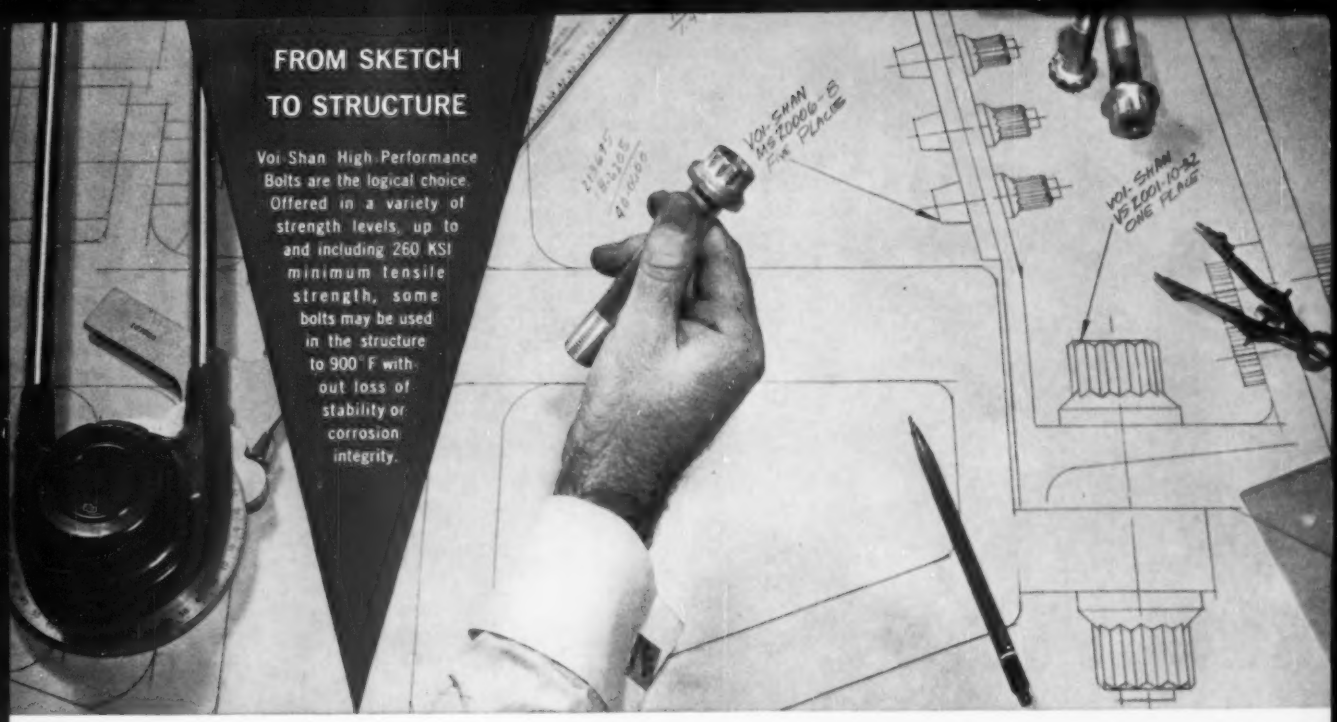
Aviation Week and Space Technology

A McGraw-Hill Publication

February 15, 1960

First Design Details Of Vertol YHC-1B

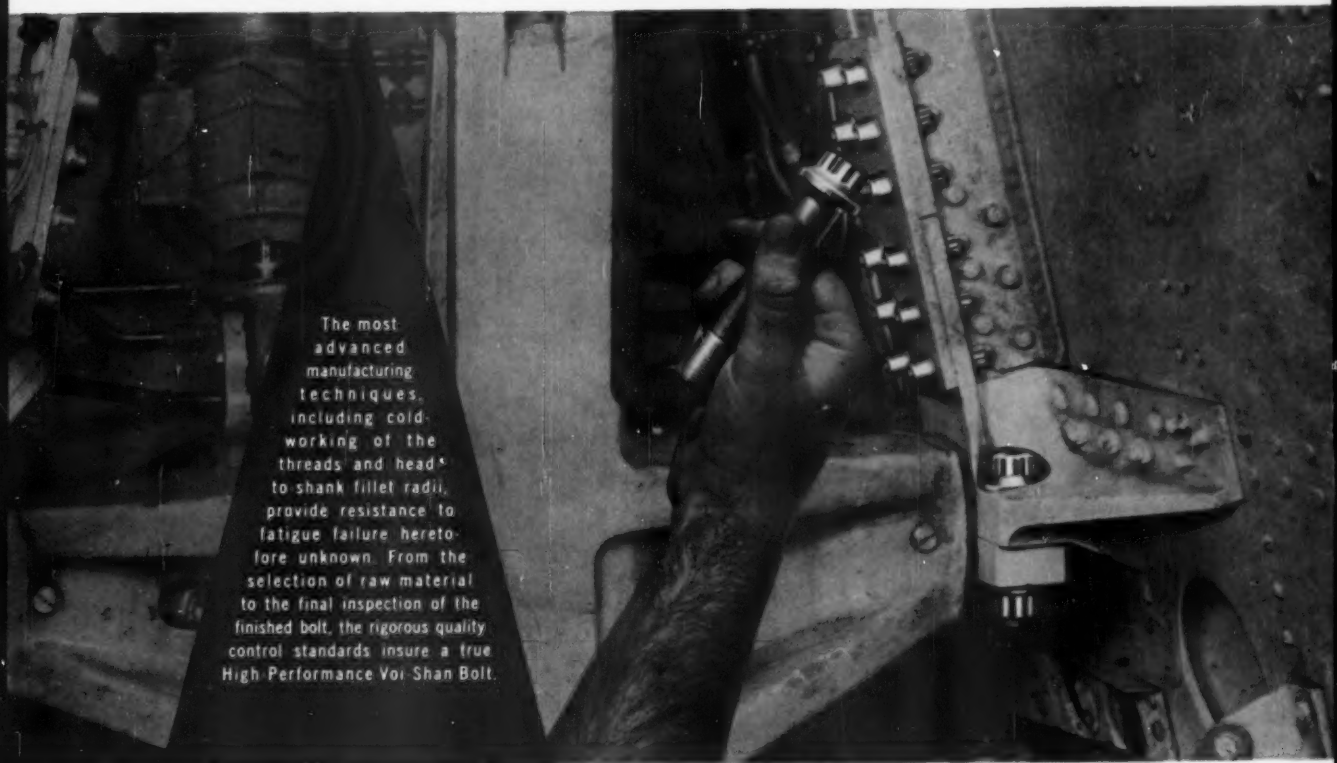
Delta Convair 880 Jet Transport



FROM SKETCH TO STRUCTURE

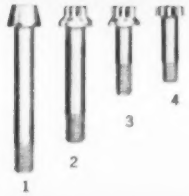
Voi-Shan High-Performance Bolts are the logical choice. Offered in a variety of strength levels, up to and including 260 KSI minimum tensile strength, some bolts may be used in the structure to 900° F without loss of stability or corrosion integrity.

VOI-SHAN HIGH-PERFORMANCE BOLTS



The most advanced manufacturing techniques, including cold-working of the threads and head-to-shank fillet radii, provide resistance to fatigue failure heretofore unknown. From the selection of raw material to the final inspection of the finished bolt, the rigorous quality control standards insure a true High-Performance Voi-Shan Bolt.

Boeing 707 structure photo, courtesy American Airlines



1. Internal Wrenching Tension Bolt 160 KSI
2. External Wrenching Tension Bolt 180 KSI and 220 KSI
3. External Wrenching Tension Bolt 220 KSI and 260 KSI
4. External Wrenching Shear Bolt 220 KSI and 260 KSI

Send for Brochure on High-Performance Bolts, and Locknut Catalog describing companion weight-master nuts.

VOI-SHAN MANUFACTURING COMPANY

VSI

a division of Voi-Shan Industries, Inc.

8463 Higuera Street, Culver City, Calif.

Tame any terrain with this Goodyear team. Famous Terra-Tires and Rolli-Tankers pair up to give any weapon system the "rollpower" it needs for fast, go-anywhere mobility.

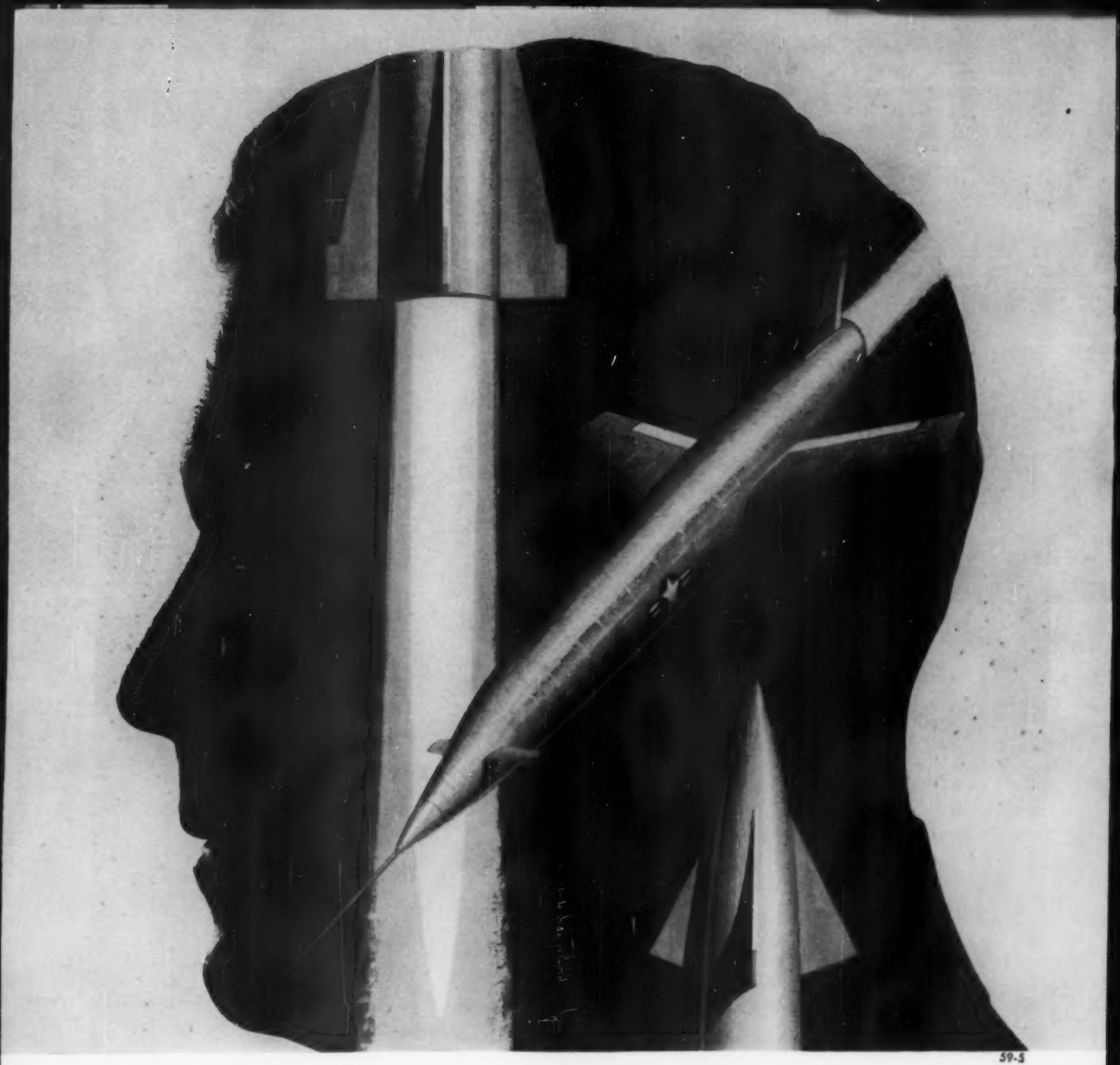
Terrain that stops tanks and other vehicles in their tracks—sand, snow, deep mud—or even rough and rocky grades—can't halt the Terra-Tire. Secret is its broad, flat "footprint" that rolls easily over soft, unstable surfaces without digging in. These superstrong Terra-Tires carry heavy pay loads into areas barred to other vehicles — yet their ride is so gentle that fragile equipment is cushioned from shock.

Working partner of the Terra-Tire is the unique Rolli-Tanker that carries up to 500 gallons of fuel or liquid supplies. It, too, goes virtually *anywhere* — floats in water when filled—can be parachute-dropped. Low rolling resistance imposes little drag, so towing vehicles can carry major loads as well.

For details on this new concept of "rollpower"—the *proved* way to give any weapon system true mobility and reduced vulnerability — write on company letterhead to The Goodyear Tire & Rubber Company, Aviation Products Division, Dept. N-1715, Akron 16, Ohio.

GOODYEAR

Terra-Tire, Rolli-Tanker—T. M.'s The Goodyear Tire & Rubber Company, Akron, Ohio



59-5

This is the first space that must be conquered

Two thousand years ago Lucan wrote about a trip to the moon. Today, the two thousand years of dreaming he inspired are close to fulfillment.

Experience in building things from dreams has always been part of Ex-Cell-O. Precision in design, precision in manufacture for forty years has been the Ex-Cell-O tradition. Now as we near the conquest of space, even more important becomes speed of translation from dream to reality. And for this Ex-Cell-O's history and facilities are yours for the asking.

EX-CELL-O FOR PRECISION (XLO)

MAN AND MISSILES FLY HIGHER, FASTER AND SAFER WITH PARTS AND ASSEMBLIES BY EX-CELL-O AND ITS SUBSIDIARIES: BRYANT CHUCKING GRINDER CO., CADILLAC GAGE CO., MICHIGAN TOOL CO.

EX-CELL-O CORPORATION
DETROIT 32, MICHIGAN

Aircraft Division

AVIATION CALENDAR

Feb. 25-26—Seventh Scintillation Counter Symposium, Hotel Shoreham, Washington, D. C. Sponsors: American Institute of Electrical Engineers; Atomic Energy Commission; Institute of Radio Engineers; National Bureau of Standards.

Mar. 7-8—Fifth Annual Business Aircraft Safety Seminar, Dearborn Inn, Dearborn. Sponsor: Flight Safety Foundation.

Mar. 9-10—Symposium on "Processing Materials for Re-Entry Structures," Miami Hotel, Dayton, Ohio. Sponsor: Midwest Chapter, Society of Aircraft Material & Process Engineers.

Mar. 9-11—Conference on the Mechanical Properties of Engineering Ceramics, North Carolina State College, Raleigh, N. C. Sponsors: North Carolina State College School of Engineering; Office of Ordnance Research, U. S. Army.

Mar. 10-11—National Flight Propulsion Meeting (classified Secret), Institute of the Aeronautical Sciences, Cleveland.

Mar. 14-15—Symposium on Load-Carrying Capacity of Bearings, American Society of Mechanical Engineers' Lubrication Division, Engineering Societies Building Auditorium, New York, N. Y.

Mar. 15—Defense Planning Seminar, Electronic Industries Assn., Statler-Hilton Hotel, Washington, D. C.

Mar. 17-18—Synchro Design and Testing Symposium, Department of Commerce Auditorium, Washington, D. C. Sponsor: Department of the Navy, Bureau of Naval Weapons.

Mar. 21-24—Institute of Radio Engineers' International Convention, Waldorf Astoria and Coliseum, New York, N. Y.

Mar. 23-25—Symposium on Optical Spectrometric Measurement of High Temperatures, University of Chicago, Chicago, Ill. Sponsors: University of Chicago's Applied Science Laboratories; Jarrell-Ash Co.; National Science Foundation.

(Continued on page 6)

AVIATION WEEK and Space Technology

February 15, 1960

Vol. 72, No. 7

Published weekly with an additional issue in December by McGraw-Hill Publishing Company. James H. McGraw (1860-1948), Founder. See panel below for directions regarding subscription or change of address. **Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y.** Publication Offices, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice President; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary. Officers of the Publications Division: Nelson L. Bond, President; Harry L. Waddell, Senior Vice President; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator.

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Single copies 75¢. Subscription rates—United States and possessions, $7 one year. Canada $8 one year. All other countries, $20 one year.

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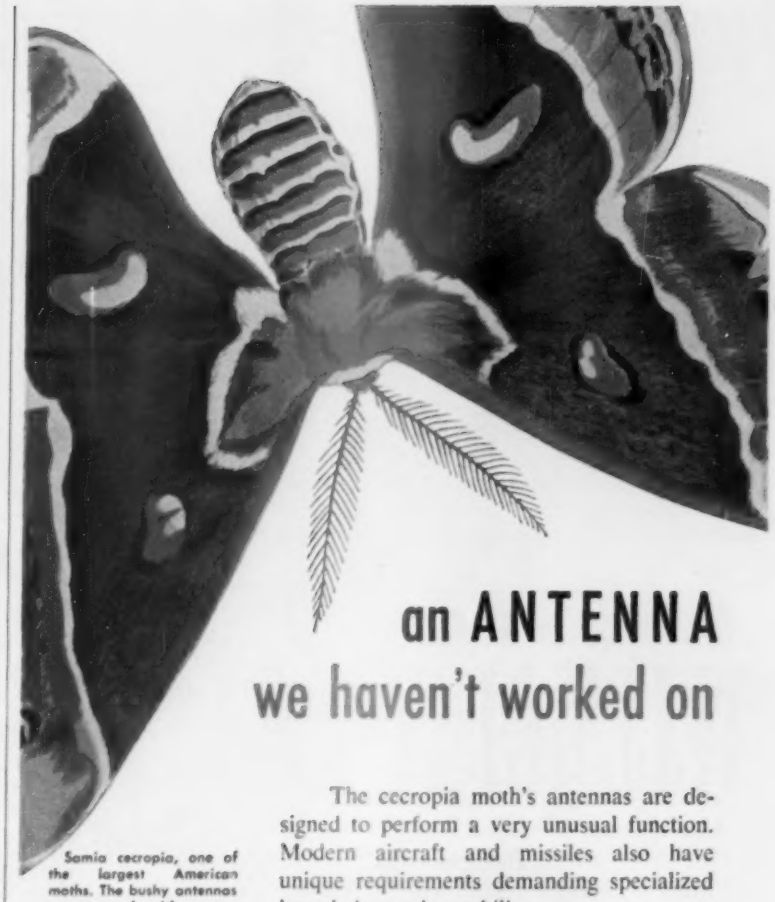

Samia cecropia, one of the largest American moths. The bushy antennas are covered with organs of smell and enable the male to locate his mate by odor from as far away as three miles.

an ANTENNA we haven't worked on

The cecropia moth's antennas are designed to perform a very unusual function. Modern aircraft and missiles also have unique requirements demanding specialized knowledge and capability.

In applying its special capabilities, Dorne & Margolin has never failed to provide practical solutions to its clients' RF systems problems.

So, when faced with an RF systems problem, think about D & M. An existing design or an easily adapted production model meeting your requirements may be available from us at low cost and great savings in time.

A comprehensive Antenna Catalog is yours on request.

Excellent positions in a growing organization affording opportunities for stock participation, as well as many other benefits, are offered to engineers. Contact R. E. Anderson, Chief Engineer.

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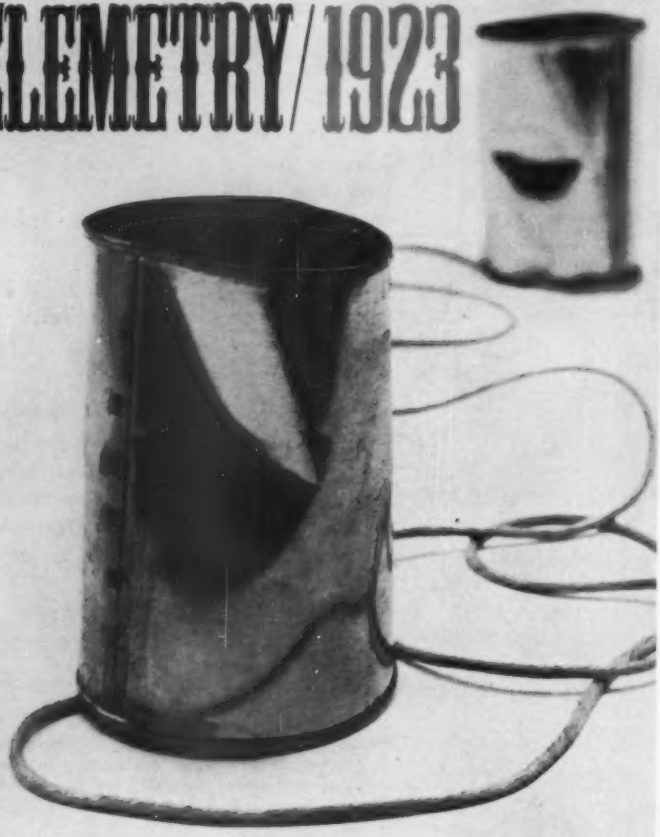
DETROIT 32, MICHIGAN

Two tin cans, a lengthy piece of taut string and two kids... many wondrous "bits" of information have been communicated by this process. As a matter of fact, the signals were oftentimes so conditioned that no adult decommutator existed that could decode them. Through experience such as this (plus quite a bit of an exorbitantly more technical nature), Canoga has developed a number of telemetry components...from the ground up (or vice versa, as the case may be). From transmitter, amplifier and airborne antenna to ground telemetry, tracking antenna and receiver... all at 2200 mc... Canoga ties both ends together.

TELEMETRY/1923



CANOGA

CANOGA/A SUBSIDIARY OF THE UNDERWOOD CORPORATION VAN NUYS, CALIFORNIA • FORT WALTON BEACH, FLORIDA

AVIATION CALENDAR

(Continued from page 5)

Mar. 23-25—Ground Support Equipment Conference, American Rocket Society, Statler-Hilton Hotel, Detroit, Mich.

Mar. 24-25—First Annual Symposium on Human Factors in Electronics, New York, N. Y. Sponsor: Institute of Radio Engineers' Professional Group on Human Factors in Electronics.

Apr. 4-8—Fourth Colloquium, Combustion and Propulsion Panel, Advisory Group for Aeronautical Research and Development, NATO, Milan, Italy. Subject: High Mach Number Air-Breathing Engines.

Apr. 5-8—1960 National Aeronautic Meeting and Missiles and Aircraft Engineering Display, Society of Automotive Engineers, Commodore Hotel, New York.

Apr. 6-8—Structural Design of Space Vehicles Conference, Biltmore Hotel, Santa Barbara, Calif. Sponsor: American Rocket Society's Structures and Materials Committee.

Apr. 6-8—1960 National Meeting "Hyper-Environments—Space Frontier," Institute of Environmental Sciences, Biltmore Hotel, Los Angeles, Calif.

Apr. 11-13—Electrical Engineering in Space Technology, Hotel Baker, Dallas, Tex. Sponsor: American Institute of Electrical Engineers.

Apr. 12-13—14th Annual Spring Technical Conference, Institute of Radio Engineers in conjunction with the American Rocket Society, Hotel Alms, Cincinnati, Ohio.

Apr. 19-21—International Symposium on Active Networks and Feedback Systems, New York, N. Y. Sponsors: Polytechnic Institute of Brooklyn; Department of Defense Research Agencies; Institute of Radio Engineers.

Apr. 20-22 — National Symposium on Manned Space Stations, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif. Cosponsors: NASA; the Rand Corp.

Apr. 21—Annual Eastern Regional Meeting, Institute of Navigation, Key Bridge Marriott Motor Hotel, Washington, D. C.

Apr. 21-22—Southwest Metals & Minerals Conference "Metals and Materials for the Space Age," American Institute of Mining, Metallurgical and Petroleum Engineers, Ambassador Hotel, Los Angeles.

Apr. 27-28—National Meeting on Space Age Materials, Cincinnati Chapter of the American Society for Metals, Sheraton Gibson Hotel, Cincinnati, Ohio.

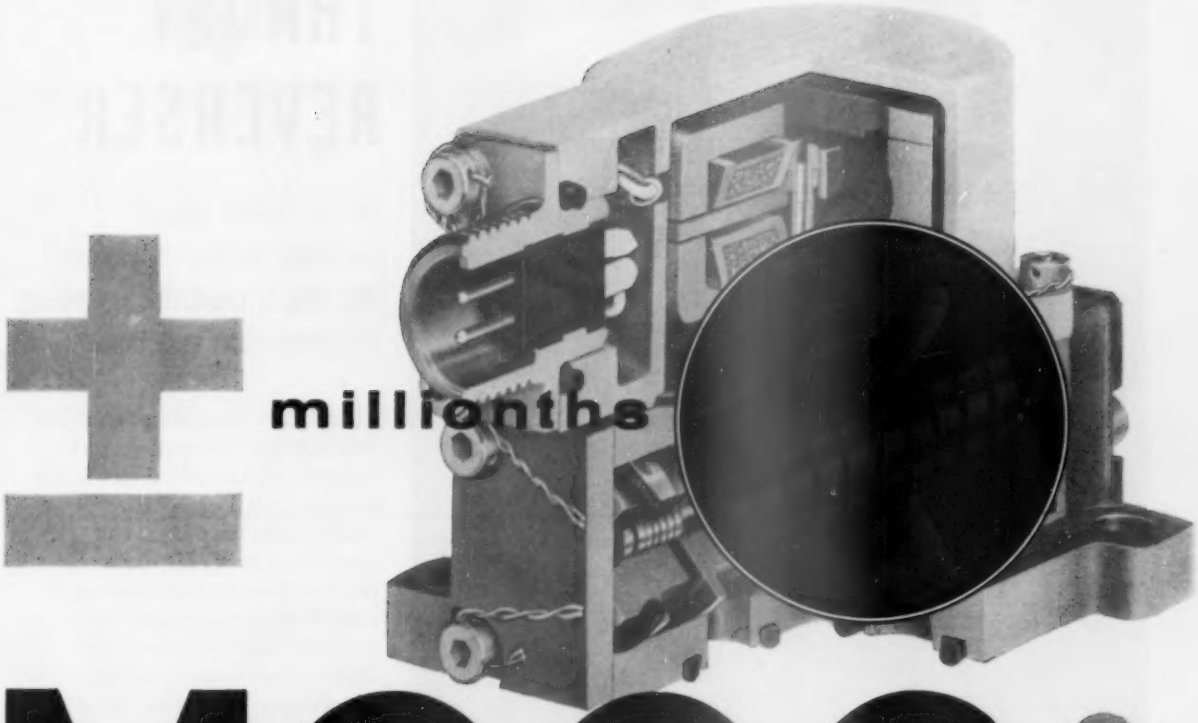
May 2-4—National Aeronautical Electronics Conference, Biltmore and Miami-Pick Hotels, Dayton, Ohio. Sponsor: Institute of Radio Engineers.

May 2-5—Sixth National Flight Test Symposium, Instrument Society of America, San Diego, Calif.

May 9-11—1960 Symposium of the Institute of Radio Engineers' Professional Group on Microwave Theory and Techniques, Hotel del Coronado, San Diego.

May 11-14—16th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

Aug. 15-20—11th Annual Congress, International Astronautical Federation, Royal Institute of Technology, Stockholm, Sweden.



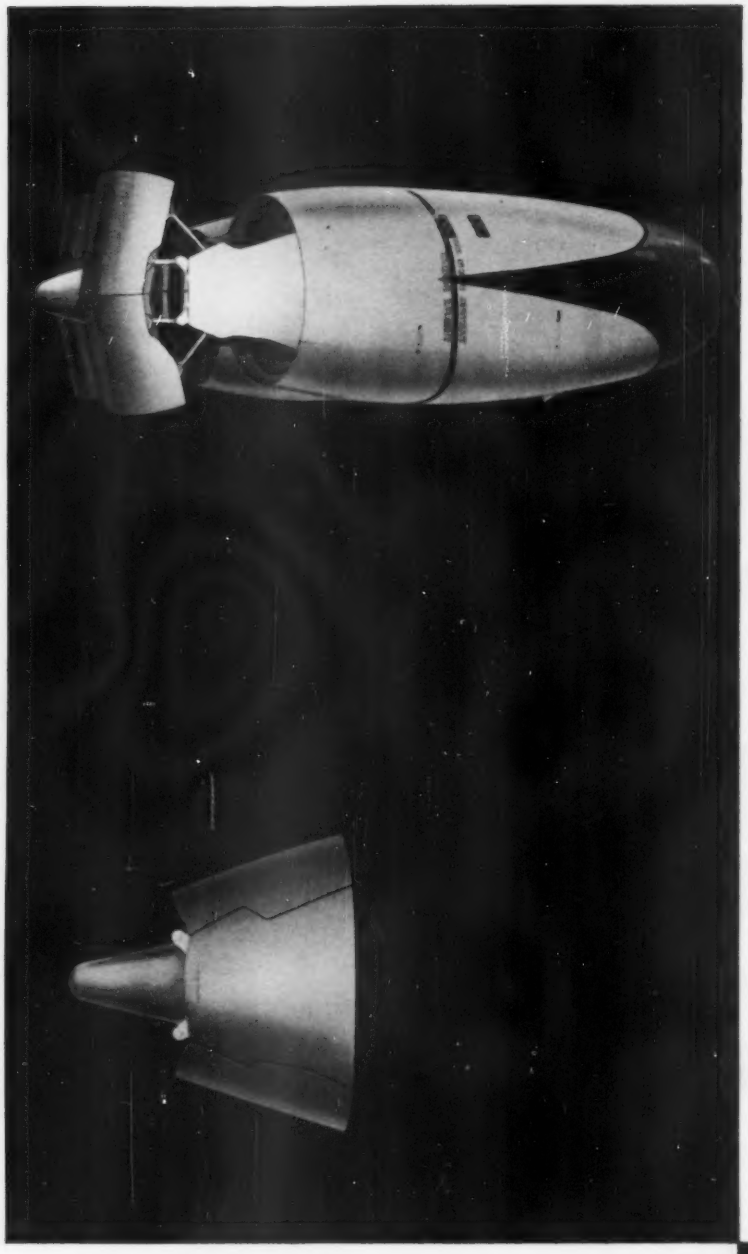
± millionths

MOOG: production tolerances.

Holding tolerances to millionths of an inch is a production skill which enables Moog to be the leading supplier of electrohydraulic servovalves. This precision production know-how has developed at Moog concurrently with the creation of basic electrohydraulic control components. Production to date of over 100,000 servovalves is vivid proof of a production capability which can support your quantity servovalve requirements.

MOOG SERVOCONTROLS, INC. PRONER AIRPORT, EAST AURORA, N. Y.

LEADING INNOVATOR AND PRODUCER OF ADVANCED ELECTROHYDRAULIC SERVO COMPONENTS

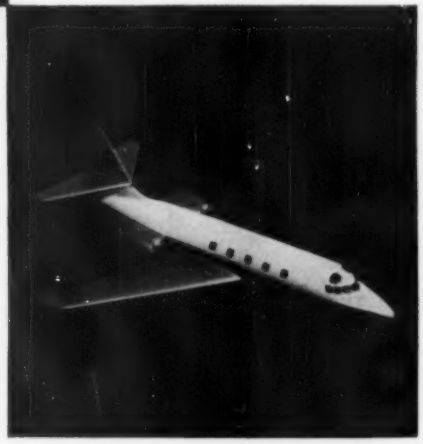


ROHR THRUST REVERSER

for the nimble new Lockheed JetStar is another example of creative engineering and production in action.

To realize the maximum versatility built into this high-performance transport, it must utilize moderate-sized airports. Rohr's answer to the problem was this unique unit developing nearly fifty percent reverse thrust for short landing runs. Working on a tight time schedule, Rohr produced a prototype which passed rigid tests with flying colors. The JetStar thrust reverser combines light weight, economy, simplicity and easy maintenance. Important, too: it can be adapted to the thrust reversal problems of many jet airplanes. Such creative engineering and production talent has been at work for years for Lockheed – and such other companies as Boeing, Convair, Douglas, McDonnell and North American.

Rohr invites inquiries from men who can contribute to the company's leadership in the aerospace industry.



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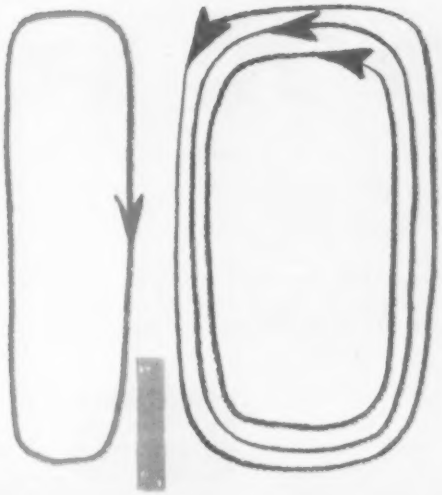
Metrisite...is the only device available today that provides a near-perfect combination of ideal transducer characteristics. The unusual properties of this remarkable new motion-sensing development are: extreme resolution... easily measures one ten-millionth of an inch; minute operating force...absolute minimum bearing friction; negligible reactive force...a fraction of a milligram; true linearity...a proven accuracy of 1/10%; high electrical output...up to 100 volts without amplification; wide range of shapes and sizes...from sub-miniature on up; exceptional ruggedness...can meet military shock and vibration tests. Now, many of the obstacles that have plagued control technology can be eliminated. Write for Metrisite details.



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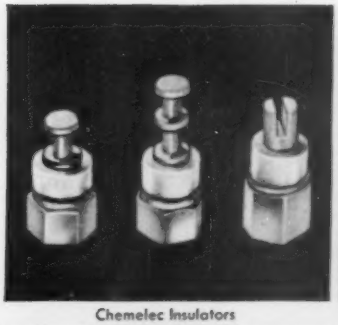
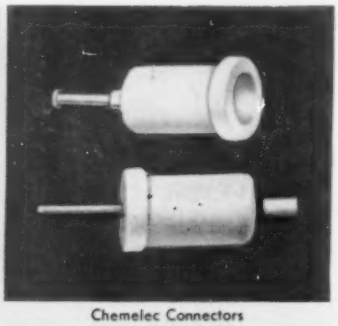
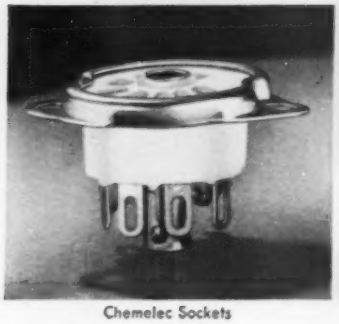
ENGINEERED COMPONENTS for the Electronics Industry



Chemelec Insulators



Chemelec Connectors



Chemelec Sockets

Plastic Shapes and Parts

RELIABILITY AT ITS ULTIMATE

Garlock electronic components are your assurance of reliable performance in missile guidance, fire control, radar, television . . . electronic systems that operate *only* as well as the smallest component within them. Garlock offers one of the most complete lines of engineered electronic components and materials available from a single source:

Chemelec* Standoff & Feed-Thru Insulators are made of Teflon† because of its exceptional dielectric properties, chemical inertness, resistance to extreme temperatures (−110°F to +500°F). The insulators resist severe shock and are designed for quick and easy installation. They are available in all sizes, designs and colors.

Chemelec Connectors are Teflon-insulated for outstanding high frequency service with plug-in crystal diodes, plug-in coils and forms, test probes. Once installed, they require no further adjustment or hardware. Male and female in .040, .050, .064 pin size, female also in .080 size.

Chemelec Miniature Tube Sockets are specifically designed for use where high or low ambient temperatures or frequency stability are problems. Body insulating material of Teflon and Kel-F**; all metal parts are precision made and plated to JAN specifications. Available in all sizes, types.

Plastic Stock Shapes and Intricate Parts, inserts, thin sections, threaded parts and precision tolerances are available. Excellent facilities and experience in compression and injection molding, extruding, machining of Nylon, Teflon, Delrin†, Kel-F.

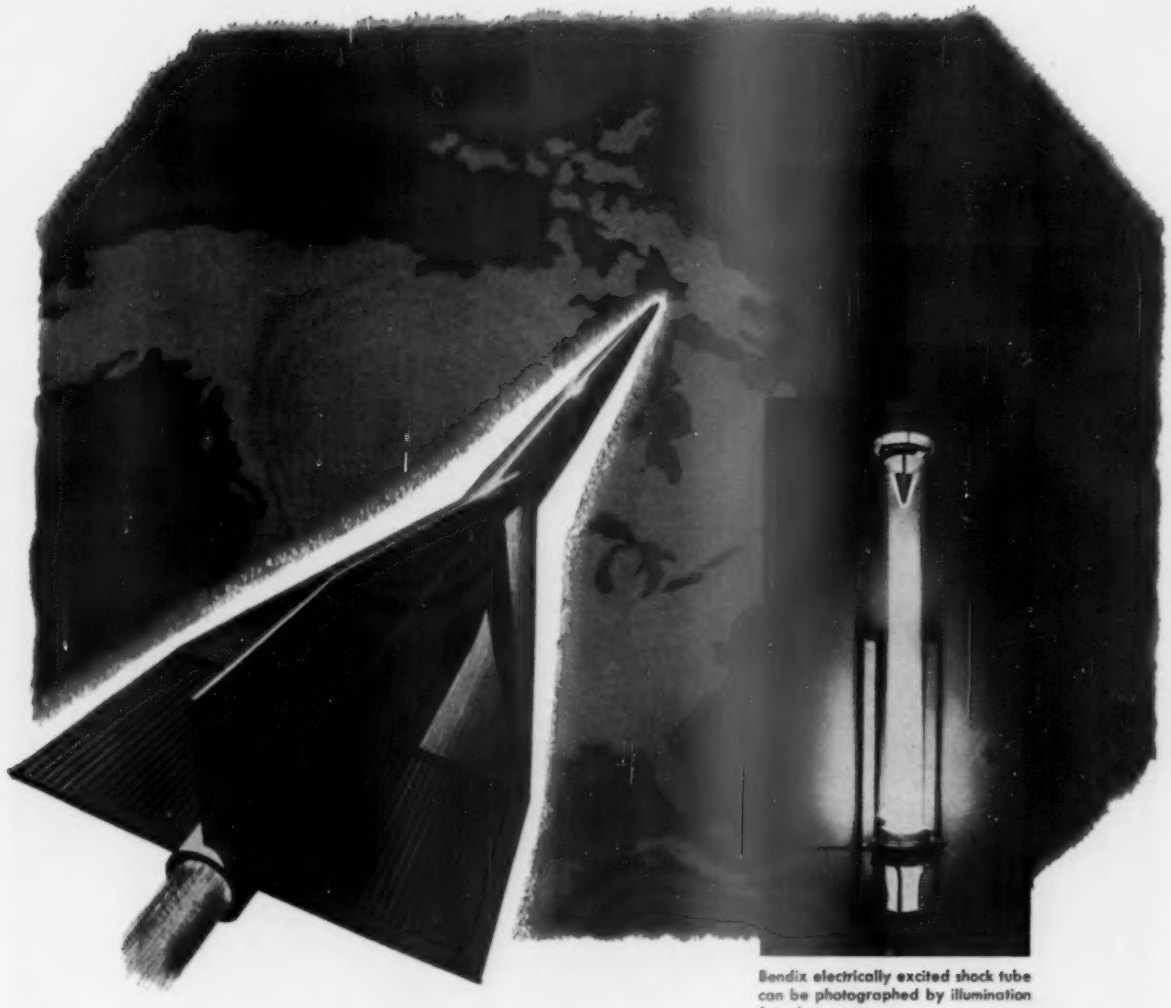
Garlock facilities and personnel are also at your disposal for design and development of new electronic products.

GARLOCK

A complete engineering staff keeps abreast of new developments in electronics, reviewing latest techniques and materials thoroughly before introducing them into component products.

Find out more about what Garlock offers. Contact the Garlock Electronic Products representative near you. Call him, or write for Catalog AD-169, Garlock Electronic Products, The Garlock Packing Company, Camden 1, New Jersey.

*Registered Trademark
**Trademark, Minnesota Mining & Manufacturing
†DuPont Trademark



Bendix electrically excited shock tube can be photographed by illumination from hot gases.

PLASMA PRODUCTION

. . . for magnetohydrodynamic investigations

Hypersonic flight can generate ionized shock layers with free electron densities as great as 10^{12} particles per cc. Temperature near the stagnation point can be as high as 7000°C. This is the self-generated environment of a missile or aircraft traveling at Mach 20 in the upper atmosphere.

To create these conditions in the laboratory for magnetohydrodynamic and electromagnetic propagation investigations requires a hypersonic wind tunnel. The Bendix electrically excited shock tube is such a research tool. Discharge of a capacitor bank into a conical region at one end of the tube instantly creates a shock wave which is driven down the length of the tunnel past the test body. Flow velocities up to 75,000 fps and temperatures of 20,000°C can be generated.

By passing electric and magnetic fields through the plasma in the shock tube, Bendix engineers can measure the attenuation of radio transmission through the ionized layer surrounding hypersonic vehicles. They can also investigate the acceleration of conducting gases for space propulsion, and the feasibility of direct conversion of thermal energy to electrical energy.

Plasma production is one of the projects being carried out at Bendix Systems Division to solve the technical problems which are the keys to the systems of the future. Other investigations include satellite communications systems, navigation satellites, advanced infrared reconnaissance, and the EAGLE Air-to-Air Missile System. Inquiries are invited from better engineers also looking to the future.

Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix
AVIATION CORPORATION

new

THOMAS A.

EDISON

oil pressure indicating system withstands vibration to 2000 cps at 20g's

Transmitter is mounted directly on engine and connected to panel indicator and power source by 3 unshielded copper wires.

Indicator is hermetically sealed — requires less than 0.6 watts to operate. When power is off pointer will move off-scale below zero. Available in 1½" and 2" (shown above) sizes. Two-inch size may be integrally lighted.

Designed for use on all new jet engines, the new Edison oil pressure indicating system consists of two components — a transmitter and panel indicator. Because the Model 318 transmitter can withstand vibration to 2000 cps, it may be mounted directly on these engines without shock mountings. As a result, it offers greater reliability, accuracy and speed of response.

Ordinary transmitters must be mounted off the engine and then connected by hose or tubing to engine pressure source. In sub-zero temperatures oil in hose can thicken and false or delayed pressure indications may result.

The new Model 318 transmitter is 50% smaller and 50% lighter (1.0 lb.) than the model 218 developed by Edison in 1956. It will meet requirements of new specification MIL-T-26638.

Its simplified electro-mechanical design makes installation and maintenance easy. Frictionless transmitter has only one moving part and maintains its accuracy in temperatures to 232 C.

For additional information write for publication 3049.

Thomas A. Edison Industries
INSTRUMENT DIVISION
49 LAKESIDE AVENUE, WEST ORANGE, N. J.

DETREX
DETREX
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Unnoticed Changes in a Metal Cleaning Operation Often Affect Solvent Consumption

We were recently asked by a large user of trichlorethylene for a sure procedure for spending the least number of dollars for this chemical.

The procedure necessary to assure the most economical use of trichlorethylene is neither mysterious nor difficult, but it is precise.

To understand it, it is necessary to accept this fact:

1) When a change occurs in the product, or
2) When a change occurs in manufacturing, or
3) When a change occurs in racking, or
4) When a change occurs in the human element, or
5) When a change occurs in the machine –

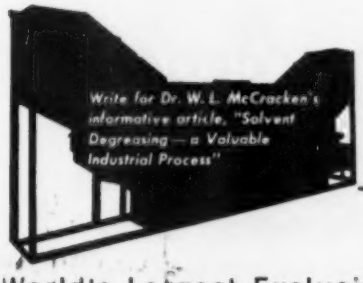
a change will also occur in the quantity of trichlorethylene being consumed. It is not unusual for one of these changes to occur every month, and many times it will go unnoticed. The *only* procedure that will get the *best* result is:

1) To ascertain the necessary facts, and
2) Have expert appraisal of those facts.

A program can be set up to cover both. We have been doing it for 27 years. We would be very happy to institute such a program for you.

Depend on DETREX for Every Metal Cleaning and Processing Need

- PERM-A-CLOR NA (Trichlorethylene)
- Solvent Degreasers
- Ultrasonic Equipment
- Industrial Washers
- Phosphate Coating Compounds
- PAINTBOND Compounds
- Aluminum Treating Compounds
- Alkali and Emulsion Cleaners
- Rust Proofing Materials
- Extrusion and Drawing Compounds
- Spray Booth Compounds



DETREX CHEMICAL INDUSTRIES, INC.

Box 501, Dept. AW-260 Detroit 32, Michigan

World's Largest Exclusive Producer of Cleaning Chemicals and Equipment

Portraits of PERFORMANCE

Two rousing tributes to the performance reliability of CECO products are the remarkable records being compiled by the jet airliners pictured above in "gallery display"—the Boeing 707 and Douglas DC-8.

Main fuel pumps for the Pratt & Whitney Aircraft engines powering each were engineered and precision-produced by Chandler Evans. Significantly, during the first exciting year of U.S. commercial jet operation, CECO pumps took part in every single service mile flown by either type of aircraft.

If pictures of missiles and aircraft which are airborne with CECO products actually *were* exhibited in a gallery, the section devoted to pump applications would be an impressive one. In addition, space would have to be set aside for future portraits, since right now . . . at Chandler Evans . . . a number of important pump design and development programs are underway.

CECO
® SYSTEMS
CONTROLS

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West Hartford 1, Connecticut

Interesting, informative literature on many CECO products is yours for the asking. Please address your request to Dept. 10.

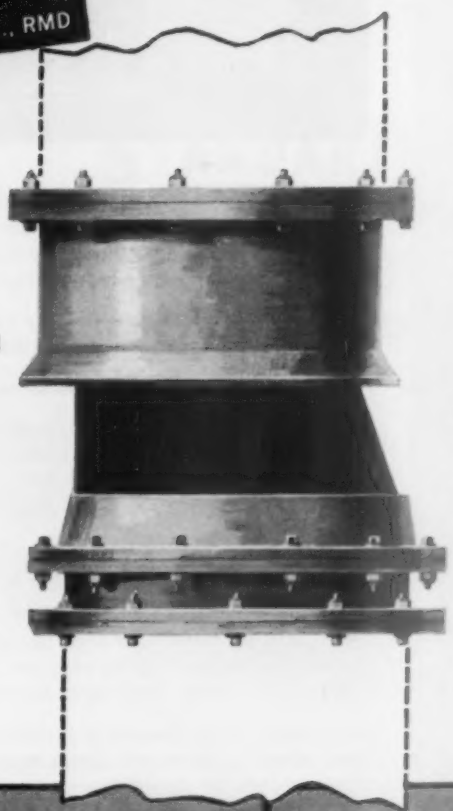
Universal Fluid Coupling and Expansion Joint

FLEXIBILITY-PLUS

in large high pressure missile and aircraft piping installations

Products of COMPONENTS DEPT., RMD

- **Qualified for missile and aircraft use**
- **No pressure limitation**
- **1,200,000 life cycles without failure**
- **½ weight of bellows**
- **Suitable for conventional and cryogenic fluids**
- **Smooth internal passageway**
- **No leakage**
- **Stands up to wide temperature extremes**
- **Currently used in Atlas ICBM**



An outstanding development in airborne system plumbing, Universal Fluid Couplings permit axial, angular and rotational misalignment and withstand greater lateral displacement than any bellows currently available. They have been qualified for 5″ and 9″ lines . . . and are available in line sizes from 4″ to 24″.

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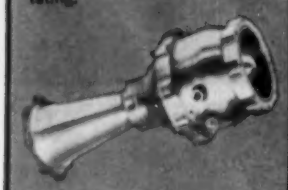

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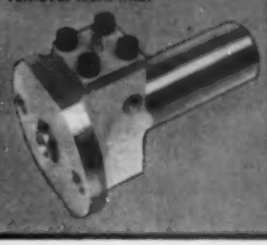

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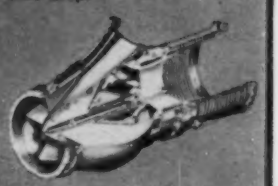

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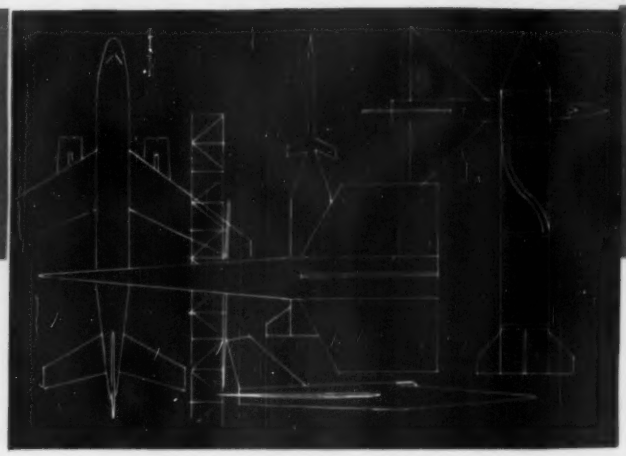

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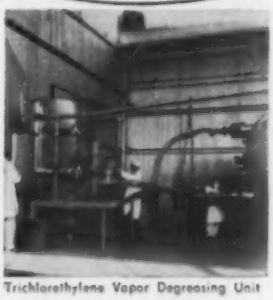

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Aviation Week and Space Technology

Vol. 72, No. 7
Member ABP and ABC

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COVER: First of 10 Convair 880 jet transports ordered by Delta Air Lines was delivered to the carrier last week at San Diego, Calif. Federal Aviation Agency certification is expected by May 1. The plane flew from San Diego to Miami, Fla., Feb. 10 in 3 hr. 31 min. 54 sec., a speed mark that apparently is a new record; the 2,338 mi. flight was timed by a National Aeronautic Assn. observer. Average groundspeed was 664 mph., with top groundspeed of 740 mph. reached on one leg. Trip was made at 30,000 ft. with 27 persons, excluding the crew, aboard. The plane is powered by four General Electric CJ-805 turbojets. For other details and flight views, see p. 45.

PICTURE CREDITS

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Present conditions no longer permit a situation quite so ideal as Thucydides' "open city" as a realistic basis for national security. Work in basic research, however, is relatively free from the restrictions that are necessary for security in other areas. Basic research at the Physical Research Laboratory of Space Technology Laboratories, Inc., is conducted in an academic atmosphere which takes full account of the fact that free communication is essential to the development of science.

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Members of STL's Senior Staff will be attending the annual meeting of the American Physical Society, New Yorker Hotel, New York City, January 27-30, 1960. They will be available for local interviews for those who are interested in openings now available at STL.

For an appointment please call Mr. T. W. Griesinger at the STL suite, Hotel New Yorker, LOngacre 3-6839 or send resumes and inquiries to:

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EDITORIAL

The Defense Debate

The running four-year debate over the effectiveness of the United States' defense program in relation to that of the Soviet Union has reached an incandescent glow on Capitol Hill that indicates it may be a major issue in the fall elections as well as a matter of vital interest to American citizens concerned with the survival of our country and its democratic institutions. One of the main difficulties in assessing the merits of the conflicting viewpoints in this bitter debate is that all contenders are basing their cases on a different time period.

For example, the Administration spokesmen in the White House, Senate and Pentagon who are assuring Americans that all is well, are talking about our military position today. This is, of course, completely irrelevant to the principal issue of the defense debate which is: Are we making the correct decisions today to ensure that our military superiority will continue for the predictable future? As Lt. Gen. Bernard Schriever, chief of the Air Research and Development Command, testified before the Senate, the decisions made in 1960 will irrevocably determine our military strength in 1964 just as the fateful economy decisions of 1958 and 1959 have made inevitable the potentially dangerous missile gap of 1961-64.

There are several strong indications that the Administration is finding it increasingly difficult to defend its military policy in the face of evidence of Soviet capability in aircraft, missile and space areas which it tried so hard to ignore and denigrate for so long. First, it has been forced to yield to critics' demands in a number of vital areas, although most of these actions are coming about a year later than they should to achieve maximum results. These retreats by the Administration include:

• **Expansion of the Atlas ICBM program** demanded by congressional and public critics a year ago when the Fiscal 1960 budget was being debated. The Administration increase in the Atlas program, however, merely tacks on more production at the end of the original schedule and does not accelerate the current production rates to provide additional capability during the critical years of the missile gap.

• **Provision of initial, though inadequate, funds to begin preparation for an airborne alert** for Strategic Air Command bombers during the period when they will be forced to operate without any certain warning of a Soviet missile attack.

• **Increased funding of the Saturn space booster program** after a year of fumbling and administrative indecision over whether this program was vital and over which agency should develop the rocket cluster.

• **Increased Polaris missile-launching submarine program,** where congressional pressure has added two-thirds of the present program size to the original budget request.

Another major crack in the Administration defense policy has come from increasing evidence that the channels through which defense information flows to the White House often deliver incomplete, distorted and inadequate facts to the commander-in-chief. It is evident that the intelligence data on which the President and his chief military informants—Defense Secretary Thomas Gates and Gen. Nathan Twining, chairman of the Joint Chiefs of Staff—are basing their position, differs considerably from the data presented to the Senate by Allen Dulles, head of the Central Intelligence Agency, concerning the Soviet missile threat.

Although the President is, in effect, the direct commander-in-chief of Strategic Air Command and has some pronounced views on the operation of SAC, he has, as far as we have been able to determine, talked directly with the present SAC commander only once in the three years he has held this vital post. It must be somewhat of a shock to the American public which still has great faith in the President's military capability to find that he has just paid his first visit to the Cape Canaveral Missile Test Center during his seven years as President. He apparently spent about as much time inspecting this key installation as it normally takes for an 18-hole round of golf.

The numerous technical inaccuracies that appeared in his two post-Sputnik television speeches on defense, the incredible episode of Trevor Gardner's 10-min. attempt to brief him on the ICBM development program several years ago and the Turkish radar incident all provide further indications that the flow of current defense information to the President leaves considerable to be desired. Another indication of the gravity of the defense issue is the Administration's desperate attempts to defend its own position by blackening the character and impugning the motives of any who dare to criticize it.

Assistant Defense Secretary Murray Snyder, who functions as an appendage of White House Press Secretary James Hagerty, has been quoted by Life magazine and Drew Pearson, without any public denial, as ordering defense officials to "kick in the teeth" of reporters who question Administration defense policies and to impugn their patriotism. Gen. Twining, in a statement that would be unbelievable if it were not part of the printed record of Senate hearings, accused defense critics of being defeatists who "would rather be red than dead." It must be obvious to Gen. Twining that defense critics want more effective defense, not less, and are urging this country to improve its position vis-a-vis the Soviet Union—not lay down and open the door to communism. This statement of Gen. Twining's must cast serious doubts on the validity of any other testimony he may provide on this crucial issue.

The basic issues involved in this defense debate are simple and clear, despite the obfuscations aimed at screening them. They are:

First, are we utilizing the full technical, industrial, military and economic capacity of this country to attain a military posture of unquestionable and undebatable superiority that will enable us to continue to provide world leadership? To this we regretfully conclude the answer at present is "No."

Second, are we organizing our defense program around the basic requirements for continued survival as a free nation in the face of the Communist challenge or are we organizing it around arbitrary fiscal limits? Again the answer appears to be a sad "No."

These are the questions the American people should continue to ask their leaders and those who aspire to leadership.

—Robert Hotz

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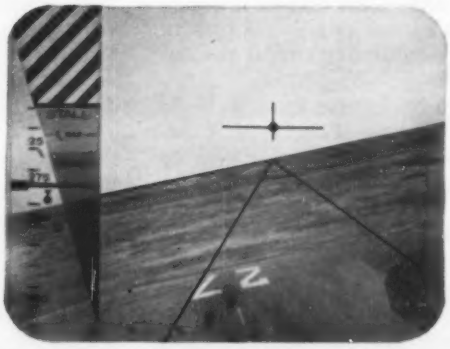

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WHO'S WHERE

In the Front Office

Maurice Lethbridge, a vice president, Eastern Air Lines, Inc., in charge of the establishment of a new department of schedules and planning.

John T. Ryan, a director, Elastic Stop Nut Corporation of America, Union, N. J. Mr. Ryan is president of Callery Chemical Co.

Dr. Eric A. Walker, a director, Westinghouse Air Brake Co., Pittsburgh, Pa. Dr. Walker is president of Pennsylvania State University and also is vice chairman of the President's Committee for Scientists and Engineers.

Emmett H. Evans, president, Dal-Tex Aviation, Inc., North Dallas, Tex.

Thomas B. Eastland, Jr., vice president, Air Carrier Service Corp., Washington, D. C., a subsidiary of California Eastern Aviation, Inc.

G. B. Clark, corporate vice president in charge of government relations, Bell Aircraft Corp., Buffalo, N. Y., and **James N. Davis,** vice president-project management, Bell's Niagara Frontier Operations. Mr. Clark continues as vice president of Bell Helicopter Corp., Fort Worth, Tex.

William B. Davis, vice president-maintenance planning and service engineering, American Airlines, Inc. Also: **William H. Miller,** vice president-New York area field operations, sales and service, and also in charge of American's European sales organization.

Glen P. Bieging, vice president-marketing, Defense and Industrial Group, Packard Bell Electronics Corp., Los Angeles, Calif.

Thomas M. Miller, vice president-traffic and sales, Delta Air Lines, Inc.

Dr. James A. Marsh, corporate vice president of engineering, Electronic Specialty Co., Los Angeles, Calif.

Capt. Charles Stein, Jr., (USN, ret.), vice president in charge of management research, United Research, Inc., Cambridge, Mass.

James S. Galbraith, a vice president, Microwave Associates, Inc., Burlington, Mass. Mr. Galbraith continues as manager of the Semiconductor Division.

Mark Kramer, vice president-customer service planning, Continental Air Lines.

Maj. Gen. J. B. Medaris (USA, ret.), board chairman of Electronic Teaching Laboratories, Washington, D. C.

Dr. Nicholas E. Golovin, deputy to the associate administrator, National Aeronautics and Space Administration, Washington.

Honors and Elections

Elmer W. Dunn, traffic manager of Lockheed Aircraft Corp.'s Georgia Division, has been elected chairman of the Eastern Regional Traffic Committee, Aerospace Industries Assn., succeeding **R. H. Ross** of the Allison Division of General Motors Corp. Also: **William R. Humphrey,** traffic manager of Kaman Aircraft Corp., has been elected chairman of AIA's Traffic Service Rate and Classification Subcommittee, succeeding **L. C. Schnetzer** of Thompson Ramo Wooldridge, Inc.

(Continued on page 158)

INDUSTRY OBSERVER

► Navy is studying plans for a single-pass photographic reconnaissance satelloid that could be launched at sea, programed to pass over a preselected point on the earth and then recovered at sea after its initial orbit. Designation of the study is Project Yo-Yo.

► **Navy-Advanced Research Projects Agency's Transit 1B Thor-Able star navigation satellite is now tentatively scheduled for a mid-April launch. Payload is being supplied by the Johns Hopkins Applied Physics Laboratory, with systems integration and systems engineering and technical direction being supplied by Space Technology Laboratories, Inc.**

► Color-contrast method of comparing astronomical images on illuminated negatives has been developed by a Soviet scientist to help distinguish new celestial bodies from known ones. Known bodies appear black on negatives, new bodies appear red or blue. A universal comparator using this and other comparison techniques has been used to study a new small planet discovered in the constellation Capricorn in 1957 by the Kazakh Institute of Astrophysics' observatory in the foothills of the Tienshan mountains near Alma-Ata.

► **Convair's San Diego Sycamore Canyon ballistic missile static test site is scheduled to be expanded to keep pace with requirements anticipated for future programs of the National Aeronautics and Space Administration and Air Force.**

► Kaman Aircraft is entering its H-43B in the competition for an Indian government order for helicopters, bringing the total number of competitors to six. A Kaman sales representative is scheduled to visit New Delhi, Manila, Taipei and Tokyo. An H-43B also may be shipped to these points. Initial purpose of the Indian order is for high altitude supply operations in the Himalayas near the border of Communist China. Relatively small order—10-to-15 helicopters—is expected at first, but some suppliers believe the ultimate purchase could run as high as several hundred aircraft. Interim order—with the Sikorsky S-62 the leading contender—is expected within the next few weeks. Bulk order will be made after evaluation of Westland Wessex, Saunders-Roe P.531, Sud Alouette, Bell 204 Iroquois and H-43B.

► **Western Electric will use company funds to construct mechanized production facilities for the ultra-high-speed 2N559 mesa transistor, millions of which will be needed if Army's Nike Zeus anti-missile missile goes into production. Company decision is based upon its belief that the 2N559 will find a number of other military and civil uses should the Defense Department stand by its original decision to withhold Zeus production funds (AW Nov. 30, p. 74).**

► Initial Belgian order for Lockheed's F-104G Super Starfighter is expected to be for 50 aircraft, with a possible order for another 50. Original estimates of the order have been scaled down because of budgetary limitations.

► **Navy is launching a 10-year oceanographic study in an effort to improve its anti-submarine warfare capabilities. Basic information will be collected on currents, sonar transmission, bottom contours and marine life. To expedite the program, designated Tenoc, Navy is asking for a specially designed oceanographic research ship in its Fiscal 1961 budget requests.**

► New astrophysical observatory located at 4,950 ft. above sea level near he Azerbaydzhan town of Shemakha in Russia has begun operation. Three telescopes have been installed, and the Karl Zeiss optical works in East Germany is working on a 6.6 ft. diameter naster mirror for one telescope, which will be one of the largest in Europe. Radioastronomy techniques also will be employed.

► **Plans to equip the nuclear carrier Enterprise, now under construction, with Convair Terrier surface-to-air missiles have been scrapped by Navy in an economy move.**

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Washington Roundup

Defense came into sharp focus as a political issue last week. There are definite signs that key Democratic lawmakers are rallying to the critical stand taken by such presidential hopefuls as Sen. Lyndon Johnson (D.-Tex.) and Sen. Stuart Symington (D.-Mo.). And there also are signs that the Republicans are becoming deeply worried over the defense issue in this election year.

Confusion reigned on Capitol Hill as the military experts argued their cases. Chief of Naval Operations Adm. Arleigh Burke said he will ask for another $975 million next year to build an additional six Polaris submarines. Air Force Chief of Staff Gen. Thomas D. White disputed Navy claims of Polaris invulnerability and supported Strategic Air Command's plan for a B-52 airborne alert. Army Chief of Staff Gen. L. L. Lemnitzer said money for an airborne alert isn't needed now, and he asked for a force of mobile Jupiter IRBMs and for more money for Nike Zeus. Joint Chiefs of Staff Chairman Gen. Nathan Twining defended the Administration budget down the line.

Dispute Over Gap

Dispute over the gap between U. S. and Soviet missile capability is a prime factor in the defense controversy. Dispute hinges on intelligence estimates of Soviet missile capability, and Sen. Symington raised a furor last week by threatening to reveal certain intelligence data which would make the extent of the missile gap clear. Central Intelligence Agency Chief Allen Dulles was called for a repeat performance before the Senate Space and Preparedness Committees to set the intelligence record straight.

While the battle flared in the Senate, key Democratic House members aligned themselves with their party's defense stand. House Appropriations Committee Chairman Clarence Cannon (D.-Mo.), a veteran fighter for economy, said U. S. military capability is lagging. Significantly, Cannon said the situation must be corrected during the current session of Congress.

House Armed Services Committee Chairman Carl Vinson added his support to defense critics. He criticized cutbacks in such programs as the B-70 and called for a stable military posture dictated by military rather than fiscal needs. Vinson's stand was publicly supported by House Speaker Sam Rayburn (D.-Tex.).

Canaveral Trip

Republican concern over the issue was shown by President Eisenhower's rush trip to Cape Canaveral last week. As the President associated himself more closely with the space and missile effort, Republicans were conducting a broad counterattack against their critics. They denied the prospect of a deterrent gap, praised U. S. progress with missiles and space activities and were inclined to accuse critics of the U. S. military posture of a lack of patriotism.

Eisenhower contributed to the Republican defense after returning last week from his first trip to Cape Canaveral. He deplored efforts of supporters of a weapon system to promote it through publicity. He also denied that the national budget is dictated solely by fiscal policy.

A bigger defense budget from Congress seems inevitable as Democratic pressure builds for improvement of the U. S. Military posture. This pressure may also produce more money for space programs. Democrats attacking the defense budget will have to act through their control of Congress to back their stand. This means a bigger budget. The Administration cannot be forced to spend the extra money appropriated, but any further evidence of Soviet strength appearing before the election will make the Administration politically vulnerable if it has unspent defense money in the bank.

Joint Congressional Committee on Atomic Energy will investigate the Project Rover nuclear rocket program this week. Committee Chairman Sen. Clinton P. Anderson (D.-N. M.), has called hearings on the program to make sure it has enough money to move at a fast pace. Anderson expressed fear that Project Rover might be moving into the kind of lagging tempo generally associated with the aircraft nuclear propulsion program.

Wrapup

Department of Defense is resisting expansion of the definition of "selling" (AW Jan. 18, p. 26) to include the whole process of proposing, developing and producing a system, an expansion proposed by Rep. Edward Hebert (D.-La.). . . Joint Economic Committee is looking into the activities of former defense and service secretaries and has asked Defense Department for a list of all former secretaries now employed by firms doing business with Defense . . . General Accounting Office is launching an investigation of Defense Department procurement of electronic supplies and equipment to see if it involves any mismanagement or duplication and to determine whether a single agency should do the job . . . House resolution last week approved the transfer of Army Ballistic Missile Agency's Development Operations Division to National Aeronautics and Space Administration.

—Washington Staff

Attacks Increase on U.S. Defense Policy

Democratic leaders call for greater military effort; Administration, service chiefs defend deterrent force.

By Ford Eastman

Washington—Attacks on Administration defense policies increased in number and intensity last week as veteran House leaders joined Senate critics in charging that U.S. military strength is on the decline.

House demands for a greater defense effort and Fiscal 1961 expenditures in the interest of national security were made by House Speaker Sam Rayburn (D.-Tex.), Rep. Carl Vinson (D.-Ga.), chairman of the House Armed Services Committee, and Rep. Clarence Cannon (D.-Mo.), chairman of the House Appropriations Committee.

At the same time, Administration officials and military service chiefs appearing before congressional investigating committees, generally maintained that U.S. forces are adequate to meet a Soviet attack and that the U.S. retaliatory power can survive any such attack and still destroy the attacker.

One of the strongest criticisms of Administration defense policies was made by Vinson before a Veterans of Foreign Wars banquet here. The House Appropriations Committee chairman charged that "for the last decade we have measured our military requirements in dollars and not in missiles, rockets, submarines, armor, planes and men."

Vinson said that, "once the facts are known, the real hard clear facts, concerning the additional military items we need to provide for an adequate national defense program to ensure our survival and way of life, once the nation has been informed, the decision will be prompt. The people will demand increased defense efforts . . .

"An adequate defense must exist in this nation at all times, regardless of the cost in dollars. And the people will willingly bear whatever additional expense adequate defense demands . . ."

Other attacks on the Administration last week included:

• **Sen. Stuart Symington** (D.-Mo.), a member of the Senate Space and Preparedness Committees, charged that the Administration is presenting false intelligence estimates on the number of missiles the Soviet Union and the U.S. now have. Symington threatened to make percentage figures public if Administration officials continue to downgrade the estimates.

• **Rep. George Mahon** (D.-Tex.), chairman of the House Defense Appropriations Subcommittee, predicted that Congress will boost the $90 million Administration request for an air alert capability by "three or four times."

• **Rep. Clarence Cannon** (D.-Mo.), chairman of the House Appropriations Committee, charged that the U.S. is in great danger unless Congress takes appropriate action. Cannon said there should be more emphasis on submarine warfare, less on surface ships.

• **House Speaker Sam Rayburn** (D.-Tex.) said he was not satisfied with the pace of U.S. defense progress.

Two Republican senators, on the other hand, charged that too much secret defense information is being made public.

Sen. Prescott Bush (R.-Conn.), a member of the Armed Services Committee, urged that there be fewer open hearings, more closed sessions, on vital defense matters. Sen. Leverett Saltonstall (R.-Mass.), a member of the Appropriations and Armed Services Committees, charged that secret intelligence information given to the committees behind closed doors is being leaked to the press.

In his Veterans of Foreign Wars banquet speech, Rep. Vinson declared:

"At a time when our world-wide naval commitments are increasing, at a time when Soviet naval power is continuing to grow and increase its combat effectiveness, at a time when more than 400 Soviet submarines, many of them ultra-modern, roam the seven seas, our Navy is getting smaller, older and over-committed, in spite of the most clear-cut strategic lessons of recent times."

Vinson also noted that the size of the U.S. Army has been recently reduced and charged that, at the same time, the service has not been provided with the modern weapons it needs to perform the functions assigned it.

Speaking of the Soviet missile gap, Vinson said the U.S. will not match Russia's capability in the immediate years ahead unless the country is willing to make drastic sacrifices now.

He added there had been some consolation in the thought that the U.S. planned to produce the North American Mach 3 B-70 bomber but that now this was gone. He said:

"We were told that the characteristics of the B-70 under development were such that no bomber known to man could match its capabilities. But, in an effort to save dollars, the B-70 program, for practical purposes, has been reduced to a prototype item which means it will probably never be produced and certainly not in sufficient quantity to become an effective part of our arsenal.

"There can be no doubt that, by cutting back the B-70 program, we have increased the threat to our own survival by sidetracking a weapon system that would have given us a definite superiority in manned aircraft capability."

Vinson also criticized the Administration for withholding funds appropriated by Congress in the past for specific military purposes, such as an increase in the size of the armed forces. He warned that, if the trend continues, Congress will insist upon establishing manpower floors on the size of the armed forces by law.

"We must get our military forces off the roller coaster which has taken them from necessity's peak to the budgeteer's valley," Vinson said. "We must have stability in the strength of our military establishment. We must maintain our armed forces throughout the years ahead at a strength that doesn't vary from year to year. And just as we need stability in our military manpower, we also need stability in the defense establishment itself."

At a later press conference, Speaker Rayburn commended Vinson's speech, saying, "If I've ever seen a man lay it on the line, he did." Rayburn added "that it doesn't do any good to be second in anything. If you are second in an election, you lose. If you are second in war, you lose."

Rep. Cannon, in a floor speech, said the U.S. is not the most powerful nation in the world. He blamed the inadequacy of the forces primarily on the Navy for requesting surface ships instead of submarines and on the Defense Appropriations Committees for granting the requests.

"The only effective service the Navy can render these days," he said, "is submarine, anti-submarine and convoy." He added:

"They wasted precious time and priceless scientific and technical resources building the most expensive and complicated machinery since the pyramids—eggshells which will not last half an hour after the first attack. If they had given the time and attention and material to the submarine they have given other futile measures and utterly useless weapons, we today would be masters of the world situation, as

we were at the close of the Second World War."

Cannon charged that the reason Congress has failed to provide the necessary weapons is that its committees have failed to report the bills and recommend the funds needed because they listened to "admirals" who "refused to recognize" the Navy "was no longer the first line of defense."

Cannon also noted that in the past, armed forces spokesmen have repeatedly warned that the U. S. is three or four years behind the enemy.

"Now very suddenly," he said, "a new voice is heard: 'Have no apprehension. We are superior in over-all capability. We must judge the enemy not by his strength but by his intention.' Let me pause long enough to ask why he has denied his people the necessities of life to produce these weapons if he does not intend to use them. . . . We all realize the importance of not alarming the public unnecessarily or unduly, but none are more completely deceived than those who deceive themselves."

Space Technology

Army Proposes Single Agency To Monitor Military Space Effort

By Katherine Johnsen

Washington—Army is actively urging the establishment of a single military space organization in a stand similar to the position previously taken by Navy (AW July 27, p. 26). In a report to the House Appropriations Committee released last week, Army said:

"At this stage Department of Defense is in process of transferring specific systems from Advanced Research Projects Agency to appropriate military departments for further development toward operational systems. An immediate problem today is a need for close coordination of the expensive support facilities, such as launching sites, missile ranges, detection and tracking facilities and recovery means. In the Army's view, the establishment of a joint military organization is the reasonable answer. Eventually, expansion of this joint organization into a unified space command for control of operational systems would probably be appropriate as the level of operational activities increased sufficiently to warrant it."

The Army contended that space exploration offers all the military services an opportunity to improve the performance of their respective roles and missiles, adding, however, that any attempt to fix military responsibilities through the projection of earth roles "is not meaningful." As an example, the report said, "the lack of an aerodynamic atmosphere or free water on the moon would hardly justify a preemptive Army claim to lunar operations."

Army said it considered itself "best fitted for the over-all responsibility" for communication satellites, mapping and geodesy satellites, a space surveillance system and an anti-satellite defense system but that the other armed services "may well participate in development and support of these systems."

Hearings before joint sessions of the Senate's Space Committee and Preparedness Investigating Subcommittee, both headed by Sen. Lyndon Johnson (D.-Tex.), served to highlight the divergence of views between Army's current Chief of Staff, Gen. L. L. Lemnitzer, and his predecessor, Gen. Maxwell Taylor, who retired last June.

Gen. Taylor called for a sweeping reorganization of the defense establishment according to combat functions under a single Chief of Staff, and an increase in the defense budget from $41 billion to $50 to $55 billion.

Gen. Lemnitzer, on the other hand, pointed out that a defense reorganization was effected last year, adding that "reorganization and reorganization makes disorganization." Despite persistent prodding by committee members, Gen. Lemnitzer declined to challenge the Administration's $41 billion defense budget, commenting that "it is normal" for the requests of the services for funds to be reduced "in consideration of the over-all picture." Army's $13 billion request was reduced to $10 billion for Fiscal 1961.

Gen. Lemnitzer conceded that the Army "would like to have" additional funds, particularly to begin production of the Nike Zeus anti-missile system, modernize forces with aircraft, missiles, etc., and to see the airlift capacity of the Air Force for ground force movements substantially increased.

Gen. Taylor urged an "immediate" airborne alert for part of the fleet of USAF's Strategic Air Command, while Gen. Lemnitzer opposed it "under circumstances which exist today." He added, however, that he believed in the "concept."

Gens. Lemnitzer, Taylor, and Secretary of the Army Wilber M. Brucker concurred that the missile gap between the U. S. and Russia in the 1961-64 period should be partially offset by using the Army-developed Jupiter as a mobile field weapon.

In testimony before the House Appropriations Committee Gen. Lemnitzer said the Army "has long held that our long range missile effort must take advantage of the security afforded by mobility. Missiles capable of constant movement, particularly in the wastelands of the world, would not only be very difficult to locate with sufficient precision to destroy, but would draw enemy interdiction efforts away from more thickly populated areas. Within the military services, the Army naturally is the most experienced in the movement problems involved in the deployment and operation of a land mobile weapon system."

Other highlights in Army testimony included:

• **Nike Zeus.** Army's request of $323 million for research and development in Fiscal 1961 was reduced to $287 million by the Bureau of the Budget—a $36 million cut. The Bureau has frozen $137 million voted by Congress for Fiscal 1960 for pre-production. In addition to research and development funds, Army has $15 million in the Fiscal 1961 budget for construction in connection with Nike Zeus, making a total of $302 million available. However, Dr. Herbert York, Defense Department director of research and engineering, has set a ceiling of $200 million on Nike Zeus expenditures for Fiscal 1961. The 1961 allocation will bring the total funds provided so far for Nike Zeus to $877.6 million, including: 1958 and prior fiscal years, $67.2 million; Fiscal 1959, $210.6 million; Fiscal 1960, $297.8 million.

• **Pershing 500-700 mi. tactical** missile. Army is going to build this solid-propellant missile under development by the Martin Co., to the maximum 10,000 lb. weight limit established by the Office of the Secretary of Defense, Lemnitzer said, "and squeeze the maximum range out of it." The Pershing will be transportable in the Army-Vertol twin-turbine Chinook helicopter.

• **Airlift.** Gen. Lemnitzer disputed a statement by Gen. Thomas S. White that present airlift "meets the criteria established by the Joint Chiefs of Staff." He reported that, according to the requirements for a general war agreed upon by the Joint Chiefs, "there is a period of about 10 days in the important initial period in which there are shortages of airlift."

• **Lacrosse.** Army has postponed its plan for a $200 million program for a second generation of this short-range tactical missile produced by the Martin Co. because of a tight budget but will continue purchases of the first generation missile in Fiscal 1961.

Defense Leaders Dispute Weapon Roles

By Cecil Brownlow

Washington—Top military defense planners are clashing sharply over the relative invulnerability of the Polaris fleet ballistic missile system, who should control it and how many submarines should be built; on the need for a new aircraft carrier, and on whether the Strategic Air Command should receive funds to prepare for a limited airborne alert capability.

Developments last week in the battle for funds in the tight Fiscal 1961 budget included:

• **Adm. Arleigh A. Burke,** chief of naval operations, told the Senate Space and Preparedness committees that he will ask for a Fiscal 1961 supplemental budget of $975 million to provide an additional six Polaris submarines, bringing the total funded or requested thus far to 18. He said that, over-all, he wants approximately 45 of the vessels, each carrying 16 Polaris missiles.

Earlier, in testimony before a subcommittee of the House Appropriations Committee considering Fiscal 1961 budget requests, Adm. Burke described the Polaris weapon system as having "an inherently high degree of invulnerability" and termed an Air Force proposal to place the Polaris system under the strategic control of the Strategic Air Command "both impractical and dangerous." Adm. Burke told the House subcommittee that the conventional-powered aircraft carrier Navy is requesting in Fiscal 1961 is "vitally important," and told the Senate group that Fiscal 1961 funds Air Force wants to provide a limited airborne alert capability are unnecessary.

• **Gen. Thomas D. White,** Air Force chief of staff, told the House subcommittee that, while Polaris "will contribute significantly to our over-all retaliatory capability," the system "is certainly not invulnerable." Gen. White said that, "as I recall, I was the only member of the Joint Chiefs" to oppose Navy's bid for a new carrier because "its relative cost compared to its capabilities in the nuclear age is too great." Gen. White also said he agreed with the "hypothetical example" of SAC commander Gen. Thomas S. Power that the Soviets could destroy the U. S. capability of effective retaliation with 300 ballistic missiles unless an air alert system is provided for SAC (AW Feb. 8, p. 34).

• **Air Force Gen. Nathan F. Twining,** chairman of the Joint Chiefs of Staff, told the Senate committees that he will oppose any requests for additional Polaris submarines until its feasibility as a weapon system has been further established.

Polaris Progress

Adm. Burke told the Senate Space and Preparedness groups that the Polaris missile system has now passed all its "tough" tests, in apparent reference to the recent test-vehicle launchings with the guidance system installed, and that, consequently, he will ask for an additional six Polaris submarines during the coming fiscal year. Present Fiscal 1961 budget requests total $952.2 million.

The proposal made over a year ago that Polaris be placed under the strategic command of SAC so the nation's major strategic systems can be under single operational control apparently is scheduled to go before the Secretary of Defense once again sometime this month. Asked by Rep. Daniel J. Flood (D.-Pa.) to "without being profane" comment on the Air Force proposal, Adm. Burke said in a written reply later submitted to the subcommittee:

". . . The coordination of operations of ships at sea, including naval aircraft and submarines, is basic and vital to effective naval operations. Polaris submarine operations must be coordinated with those of other friendly submarines for protection, reconnaissance and mutual support. Their operations must be coordinated with friendly anti-submarine forces to insure non-interference, safety and mutual effectiveness. Their operations must be coordinated with friendly naval air operations for the same purpose.

"A proposal has been made to separate missile submarines from the operating fleets and place them in a single strategic command. This type of proposal is not new . . .

"These various proposals have been rejected as impractical as regularly as they have been advanced. The current proposal is similarly unsound and impractical. It completely ignores the fact that, in the case of missile submarine operations, the prime requisite is for coordination of the submarines prior to the launching of the missiles."

The written reply concluded that "the proposal to remove Polaris submarines from our operating fleets and

New Soviet Aircraft Developments

Washington—Air Force Chief of Staff Gen. Thomas D. White told a House appropriations subcommittee last week that the Soviets are "continuing production at a reduced rate of their heavy bombers," that a new supersonic Soviet four-engine aircraft in the 300,000-lb.-class "has been seen" and that the Russians are developing a transport that "could operate at supersonic speeds."

Gen. White told the subcommittee that, despite Premier Nikita Khrushchev's statements that the Soviet Union will rely primarily upon ballistic missiles, "we have plenty of information that their manned aircraft are continuing to be exercised and maneuvered at a very high rate, in fact, at an increased tempo." Later, in a written reply to subcommittee queries on Soviet aircraft developments, he said:

"The Air Force does not have intelligence that confirms that the USSR is building a supersonic transport aircraft which in performance and size is the equivalent of the (Mach 3) B-70. However, the USSR does have designers of proven ability; they have the technical knowledge required, and they also have the necessary production facilities. There is no question of their capability to produce such an aircraft.

"A Soviet four-engine jet aircraft, probably configured for supersonic flight and in the 300,000 lb. class, has been seen. This aircraft is estimated to be a bomber prototype, however, and is referred to as the Bounder.

"The USSR is also working on a transport aircraft that could operate at supersonic speeds, but this aircraft appears to be smaller than a B-70 type. Such an aircraft will greatly augment the capabilities of their air transport organization, Aeroflot, which can be quickly converted to an adjunct of the military air forces. The world-wide gain in prestige accruing to the Soviet Union from the early introduction of a supersonic transport comparable in size to the B-70 would be invaluable to a nation involved in the airpower race.

"A supersonic transport could be designed so that it could carry air-to-surface missiles under its wings. However, any such transport plane would require adaptability to such items as special bombing and navigation equipment and perhaps pylons for missile attachment. Such adaptability should be detectable.

"Aeroflot, the Soviet commercial airline, is organized into regional or geographic groupings for administrative purposes similar to the Military Air Transport Service in the United States. Also, almost all administrative, as well as operating personnel of Aeroflot, are known to be either reserve Soviet military personnel or officers on detached service from the Soviet air force."

lump them into an over-all strategic command is both impractical and dangerous."

Gen. White, when asked for his evaluation of the Polaris as a weapon system and its invulnerability to attack, told the House subcommittee "it is one of several systems which promise to be effective and will complicate the enemy's defenses." He added, however:

"The Polaris weapon system itself is certainly not invulnerable. The Soviets have a very much larger submarine fleet than we. I cannot conceive that a threat such as I think that can pose to the Soviet Union would exist long without some defense—some very effective defense being worked out.

"One thing that occurs to me right away, of course, is that the submarines will be operating on the high seas. Well, there is nothing to prevent another submarine from staying right behind your submarine under international law. He can be right within firing distance all the time. With the number of submarines that the Soviets have —and presumably they will have more— I am sure that invulnerability is the wrong word. There is no question about the fact that it is a difficult target, but not invulnerable."

As expected, Gen. White also strongly defended the original Air Force request for $456 million for early development of the North American Mach 3 bomber as an operational weapon system, as opposed to the Administration-dictated request for $75 million designed to provide two prototypes.

Under questioning, Gen. White told the subcommittee that the Administration decision will delay the appearance of the B-70 as an operational bomber by at least two years, although first flight under both programs is scheduled for Aug. 1, 1963. Later, Lt. Gen. Mark E. Bradley, Jr., USAF deputy chief of staff for materiel, told the subcommittee that a study is now under way to try and accelerate the initial flight date to December, 1962, without the need for additional funding.

Gen. White said that, in the Strategic Air Command's Fiscal 1961 priority list, the B-70 held "the highest priority after weapon systems presently in existence"—the Boeing B-52, Convair B-58 and ICBM systems.

He told the subcommittee that, although no funds are currently provided in the Fiscal 1961 B-70 requests for further development of the aircraft's bomb-navigation system, "we are tentatively planning to keep the team of scientists who are working on that system together and go slowly along with the system on the recommendation of the scientific community . . . because this is the important thing if we decide to make a bomber."

So far as the SAC priority list is concerned, he told the subcommittee that:

"The B-58 . . . was about the third priority weapon system in the Strategic Air Command submission, not including consideration of airborne alert requirements. The second, or perhaps the first, was B-52s, then the B-58 and then the B-70. The point being that the first three weapon systems are ones that are in being, and the B-70 was one for the future. Gen. Power was particularly concerned to have more weapons as soon as possible . . ."

B-58C Procurement

Gen. White also told the House subcommittee that the Air Force is seriously considering the advisability of asking for funds for procurement of the Convair B-58C, an all-supersonic version of the basic Hustler with a reported speed above Mach 2.5. Powerplants are 30,000-lb.-thrust-plus Pratt & Whitney J58 turbojets.

Joseph V. Charyk, assistant secretary of the Air Force for research and development, said first operational squadrons of the B-58C could be available in 1963 and that, with 1965 as the earliest operational date for the B-70, "I think there is little question that it would be attractive to have a supersonic bomber of this range in this time period."

Charyk said, however, that before a final decision is made within the Air Force, USAF hopes to determine whether "this kind of capability is technically feasible within the kinds of dollars that are being talked about, whether it can do the job and how it will compare with the kind of capability that would be achieved by other means."

Over-all, Gen. White said present Fiscal 1961 budget requests provide for a total of 633 aircraft, including three trainers—the Cessna T-37, Northrop T-38 and North American T-39—but no funds for the Convair F-106, which he termed "the last of the fighter interceptors unless funds are subsequently programed to pursue the development of a more advanced interceptor type aircraft."

Possible successors to the F-106, if the North American F-108 Mach 3 interceptor is not revived, include a proposal "for a much less expensive aircraft that will be less sophisticated but which can do a large percentage of the job of the F-108." Other proposals, he said, include use of the B-58 as an interceptor and Air Force adoption of the North American A3J which Navy plans to employ primarily as an attack plane.

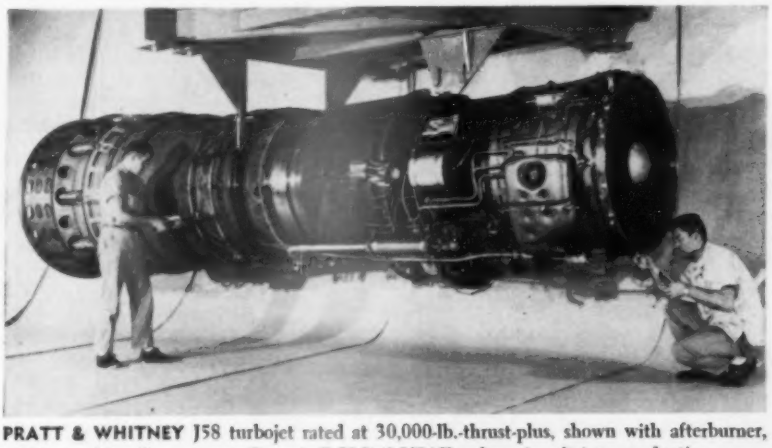
Navy Fiscal 1961 budget requests include a total of 658 aircraft, including 12 different types, all of them combat. Adm. Burke told the House subcommittee no administrative or training types of aircraft are included "although we need them."

Aircraft to be procured include the Chance Vought F8U-2N, McDonnell F4H-1, Douglas A4D-2N, Grumman A2F-1 low-altitude penetration aircraft, North American A3J-1, Grumman W2F-1, Lockheed P3V-1 anti-submarine aircraft patrol plane version of the Electra turboprop transport, Lockheed GV-1 (C-130) turboprop transport and the Grumman S2F-3 search aircraft.

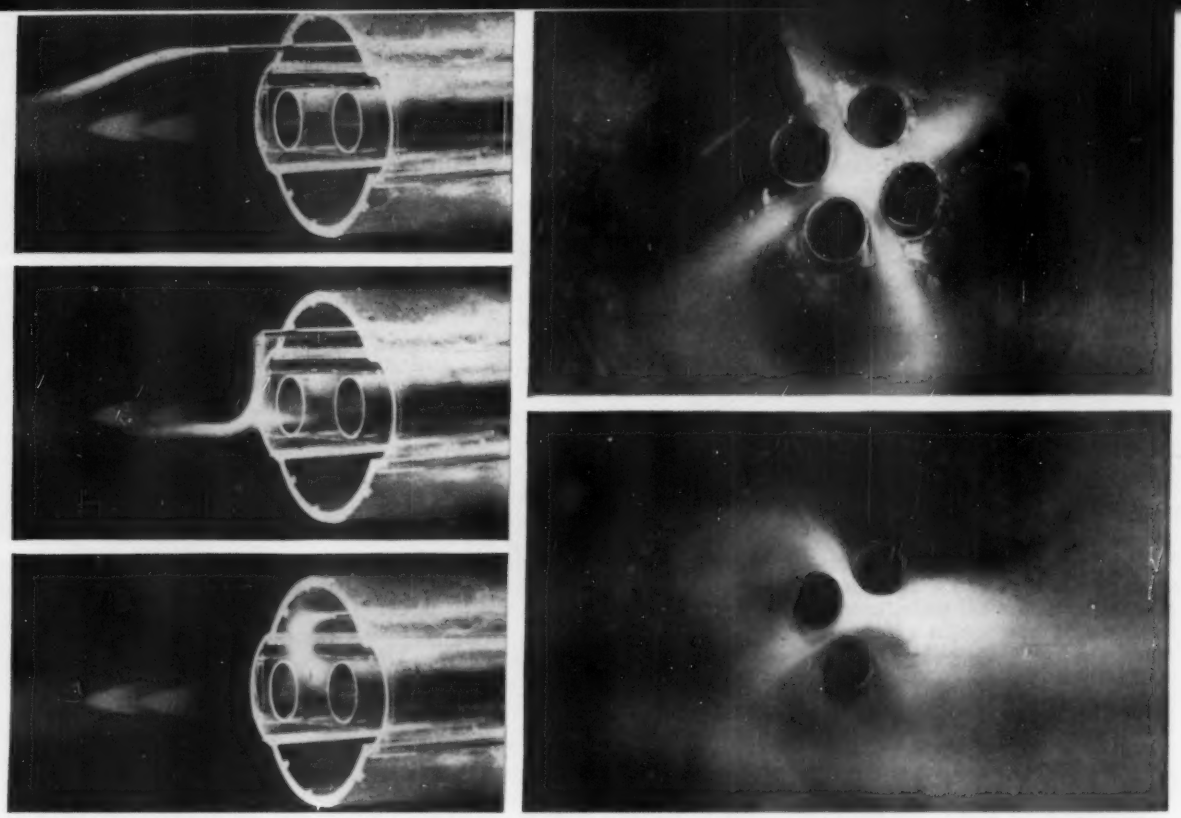
Helicopters include the Sikorsky HSS-1 and HSS-2, the Kaman HU2K-1 and the Gyrodyne DSN-3 drone which will be deployed aboard destroyers as search vehicles in Navy's anti-submarine warfare "Dash" concept.

Project Artemis

Washington—Significant Navy research and development work in the anti-submarine warfare field includes Project Artemis, "a research program to establish the feasibility of ocean area active sonar surveillance," according to Chief of Naval Operations Adm. Arleigh A. Burke in testimony before a subcommittee of the House Appropriations Committee.



PRATT & WHITNEY J58 turbojet rated at 30,000-lb.-thrust-plus, shown with afterburner, will be used in all-supersonic Convair B-58C if USAF orders aircraft into production.



REVERSE FLOW (left) is demonstrated by high pressure air jets simulating hot rocket exhaust. Traversing probe releases smoke flowing downstream; as extended probe is retracted (center) with smoke going up and downstream, smoke is drawn back as probe fully retracts. Smoke is released at center of base (right). High pressure jets issuing from all four nozzles (top) result in high base heating. When one jet is shut down (bottom) smoke released at base no longer is trapped and heating becomes much lower.

AEDC Accelerates Ground Rocket Tests

Tullahoma, Tenn.—Greatly increased emphasis on ground testing of rocket engines under altitude conditions was stressed in the first U. S. symposium on the subject held here recently, less than two years after the first significant work in this area was begun.

The symposium at the Arnold Engineering Development Center was sponsored jointly by ARO, Inc., operating contractor for AEDC, and Space Technology Laboratories, Inc. Twenty-two technical reports were presented by representatives of military organizations, industrial firms, NASA and the two sponsoring companies.

Main points made at the symposium:

• **Erratic base flow** behind a missile powered with a clustered rocket engine. Rocket nozzles clustered with a dead-air space in the center cause reverse flow of hot gases back toward the base of the missile. Reverse flow not only heats the missile base but is forced out past the rocket engine nozzles at high pressures into the airflow surrounding the missile. These narrow high pressure gas streams have proved unstable under certain conditions and have caused the thrust vector of the cluster to fluctuate rapidly. This type flow problem has occurred at all altitudes.

• **Improper location** of the auxiliary gas turbine exhaust pipes on large ballistic missiles resulted in the recirculation of fuel-rich exhaust mixtures back behind the missile. The missile base acted as a flame holder at low and medium altitudes so that external combustion of the turbine exhaust occurred against the missile base, causing structural overheating and apparently on some occasions, missile failure. At high altitudes, this problem does not occur because the external air stream does not have enough oxygen to support the combustion of the turbine exhaust. Use of a long exhaust pipe to take the gases away from the missile base proved to be an adequate fix for this problem.

• **Bell Hustler liquid fuel** engine proved to be reliable during most altitude chamber testing at AEDC, but these tests also revealed that the engine had poor altitude start characteristics after a prolonged period of coasting in space. The engine's altitude ignition capability approached a limit when the propellant temperatures dropped from 100F to 30F. One of the fixes found for this condition was to stop prepressurizing the combustion chamber by evaporation of the oxidizer. These Bell engine tests in March, 1959, were the first to be conducted at AEDC on engines with thrust greater than 2,000 lb.

• **Third stage engine** for the Thor-Able lunar probe was the first full-scale solid propellant engine to be tested at AEDC. Primary objective of tests in June, 1958, were to determine the total impulse of the engine through its altitude envelope. Tests showed that the predicted total impulse was in serious error. Other solid fuel engine problems detected under simulated altitude testing are chuffing or unprogramed burning after engine shutdown, inaccurate heat transfer data for most nozzle configurations at altitude and nozzle erosion by solid exhaust particles, such as aluminum, at altitude. Solid exhaust products also caused flow separation in the nozzle and resultant performance reductions before serious erosion began.

Total hours of simulated altitude testing of all the rockets tested by AEDC is believed to be much greater than those accumulated by any other U.S. facility. Full-scale and model rocket engines with thrusts up to 60,000 lb. and burning times of up to five minutes have been fired a total of 740 times at simulated altitudes of 100,000 ft. and above. Approximately 310 of these have been solid fuel firings, 430 liquid fuel firings.

Soviets Study Moon 'Transit Stations'

Washington—Soviet rocket progress now makes it possible to put into orbit satellites that will weigh several tons and will serve eventually as "transit stations" for manned flights to the moon and planets, Russian scientists said.

Recent Soviet references to these large, earth-orbiting satellites make them sound as if they might be launching bases for interplanetary rockets rather than merely necessary experimental steps that must precede launching of manned rockets directly from the earth.

For the first time, the new "more powerful" ballistic rocket recently fired by Russia in Pacific tests (AW Feb. 1, p. 25), has been referred to by a Russian commentator as a "ballistic missile" and by the official Communist China news agency as "the Soviet multistage ballistic missile." All official announcements of the test firings through the Russian news agency Tass and Radio Moscow have called the vehicle a "rocket," making no reference to missiles.

China also spoke of "intercontinental ballistic missiles" in connection with the tests and said: "The safe return of cosmic missiles to earth is one of the most important questions to be solved in the study of ICBMs and in the study of human flight into cosmic space."

G. G. Kuznetsov, a Kamchatka Pedagogical Institute professor of physics, pointed out that the rockets tested in the Pacific covered a distance "equal to over one quarter of the earth's circumference along the equator" and "confirmed once more that there is now no point on the earth's surface, sea or land, that cannot be reached by rockets."

Nikolai Varvarov, described by Tass as "an authority on astronautics," wrote in Komsomolskaya Pravda that progress in rockets, rocket engines and guidance systems "already makes it possible to orbit Sputniks several tons in weight." This will permit the orbiting of telescopes, radio telescopes and the return of photographs to earth by jettisoning containers or by television, he said.

Large Sputniks also "open up great prospects for solving the problem of world-wide telecasting" and offer the possibility of meteorological observatories, circling the earth "in 1.5 to 2 hr.," Varvarov said.

Kuznetsov said it will be possible "in the not distant future to create a big, permanent, artificial earth Sputnik which will serve as a huge scientific laboratory to conduct research into various types of cosmic radiation and study the effect of space flight on the human organism.

"Eventually, this Sputnik will serve as a unique kind of transit station for human flights to the moon and other planets of the solar system."

Two other Soviet scientists wrote of heavy earth satellites in connection with the recent tests and said heavy satellites are necessary steps toward space ships. Only one of them, Prof. Yv. Pobedonostsev of the USSR Academy of Sciences' space commission, spoke of the orbiting station as if it were to be a launch base.

In an article in Zemedelsko Zname, Pobedonostsev noted that "a space platform orbiting the earth must be set up for launching rockets to other planets," according to a Bulgarian broadcast.

Prof. Gorgiy Pokrovskiy, also a member of the space commission, said the recent test firings tested an "automatic guidance system developed in the USSR" and proved its "exceptional dependability and accuracy." The rocket system is "absolutely dependable and stable," Pokrovksiy said.

The Chinese article which called the rockets "intercontinental ballistic missiles" said Soviet scientists have "devised many means to diminish missile speed" on re-entry, including installing "a braking jet engine on the cosmic missile" and installing "two wings on the missile and (directing) the missile's flight into the atmosphere and toward the earth, not at a vertical angle, but at a special angle so that it will gradually reduce its speed and land in the same way as an aircraft."

Titan Test Silos Under Construction

Vandenberg AFB, Calif.—Construction of silo launch test facility (SLTF), in which Air Force-Martin Titan ICBM will be tested for firing from bottom of the silo is well under way here.

SLTF is in addition to operational suitability test facility (OSTF) and training facility-one (TF-1), both of which are expected to be operating late this year (AW Jan. 18, p. 67). OSTF and TF-1 both provide for Titan to be lifted to the surface by an elevator for engine ignition and launch.

Silo bottom launch is but one phase of Titan improvement program. Test silo is funded, but there is no provision beyond this for operational use of this type launch. One phase of Titan improvement known to be funded is inertial guidance system, built by AC Spark Plug according to a Massachusetts Institute of Technology design, which will replace current radio-command guidance. Exactly when this inertial system will enter operational use is uncertain.

It is expected that TF-2 and TF-3 Titan training facility complexes, which also are to be built here later, will incorporate improved Titan provisions, perhaps even the silo-bottom launch technique.

There have been no full-scale Titan airframe firings in a silo-bottom environment, although there may have been hot firings of two Aerojet LR-87 first stage Titan booster engines, rated at 300,000 lb. thrust, in a silo or a similar environment.

Among other things, SLTF will test ways of removing liquid propellant rocket engine exhaust gas. Possibilities include allowing gas to flow directly up around the missile, out through an exit at silo base to an annular passage around silo structure and to the surface, or through a U-shaped excavation where one vertical arm is the silo and the curved bottom and opposite vertical arm are gas exhaust passages.

Test silo also will be used to investigate ways to dispose of the tremendous amount of acoustic energy the rocket engines will generate during thrust-buildup and missile exit.

Titan operational bases are funded for T-1 through T-6, each base representing one squadron of nine missiles except for T-1 at Lowry AFB, Denver, Colo., where two squadrons will be located. These six installations will be highly similar, if not identical, in contrast to Atlas program where base design varies significantly among the first operational sites as major improvements are incorporated one at a time rather than in a group.

It is anticipated Titan T-7 and subsequent bases through the 14 total squadrons authorized for the Martin two-stage missile would use silo launch, but although they are programed, construction has not begun on these later bases. The T-7 base also most probably would be the point in the Titan program where the missile would become operational, incorporating all possible product improvements.

Cost of hard Titan sites ranges from $43 million to $49 million each, depending on whether the deployment has one control center for every three launch silos in a complex or one control center for each silo in the unitary concept. The latter approach would almost surely have the ICBM fired from the silo bottom, reducing to a few seconds the time during which the base would be "soft" (with the silo lid off) during launch.

ARDC Plans Index of Industry Skills

By Philip J. Klass

Washington—Air Research and Development Command plans to draft a register of 30,000-to-50,000 scientists and engineers working in all fields of technology to permit fast access to experts in any given field and reduce duplication of scientific effort.

The program, known as Project Cate for Current ARDC Technical Efforts, is scheduled to get under way within the next several weeks.

Beginning Mar. 1, Air Force contractors and subcontractors will be asked to have their engineers and scientists fill out small cards to show which of 33 different technical fields in which they are currently working, with a more detailed breakdown into one or more sub-areas and additional key words to describe the specific nature of the individual's work.

The information assembled by ARDC will be reduced to punched card form and be used in these two basic ways:

• **Technical rosters,** one for each of the 33 technical fields, which lists every Air Force engineer and scientist engaged in that area together with key words which describe his particular specialties plus his address and telephone number, will be printed and distributed to all engineers and scientists who register with Cate. Each of these Air Force scientists in turn will have a more complete technical roster which also lists all registered engineers and scientists in industry and their specialties. If an industry engineer or scientist needs technical assistance, or wishes to find out who else is working in a particular area, he will be able to look through his roster of USAF scientists and find the man who specializes in this area. If the Air Force scientist cannot provide from first-hand knowledge the answer the industry scientist needs, the Air Force scientist can refer to his complete Air Force/industry roster to recommend other scientists in industry who can be contacted.

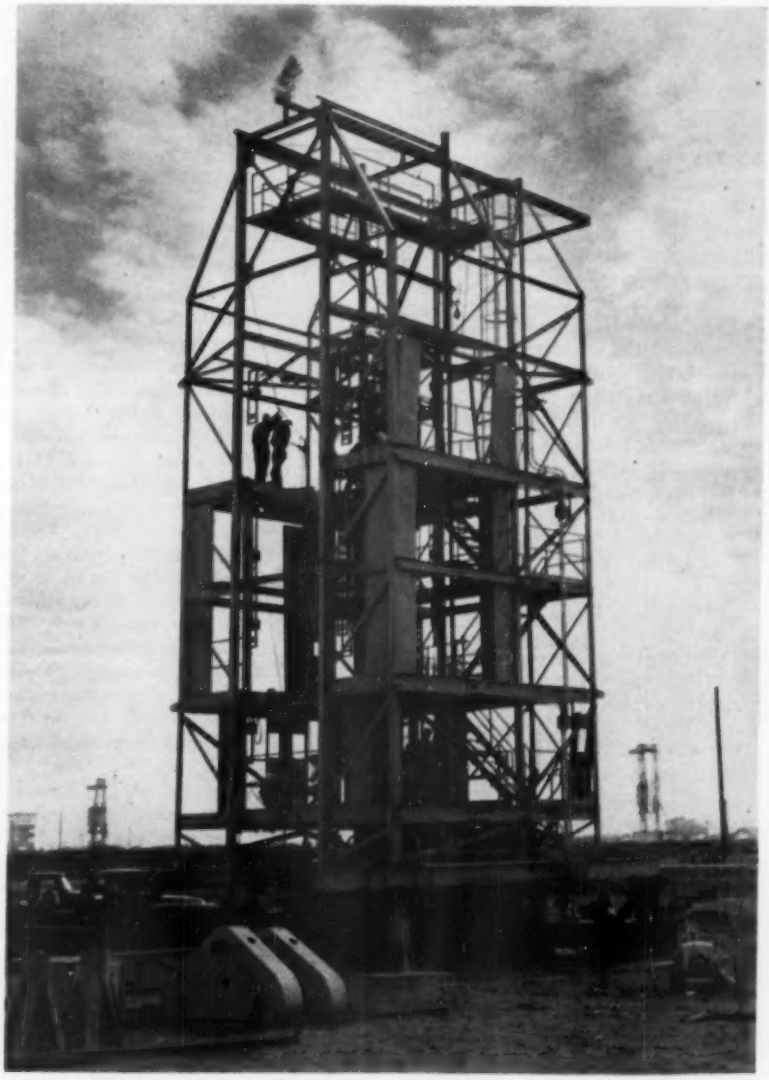
• **IBM 9310 computer** and a small staff at Air Force Research Division's Project Cate office will be available for consultation and machine-search of its extensive punched card register for hard-to-find skills. Inquiries can be made by telephone or by teletype.

Air Force and industry engineers and scientists will be asked to fill out the Project Cate information cards every three months so that rosters can be kept up-to-date and revised quarterly.

Project Cate already has undergone several months of trial operation, using a register of about 2,400 Air Force engineers and scientists, with marked success, according to Lt. Col. James Vann, ARDC, who heads the program. Approximately 600 industry inquiries have been received and processed at Cate headquarters, with an average of less than 20 min. being required to locate the appropriate USAF specialist.

The decision to publish rosters of USAF scientists and their areas of specialty for distribution to industry is expected to greatly accelerate the process by enabling industry to go directly to the Air Force specialist without working through Cate headquarters for routine inquiries.

At present, the 33 major technological fields, each assigned a code number from 0100 to 3300, include: advanced weapons, biosciences research, communications, computer techniques, deceleration devices techniques, electromagnetic vulnerability reduction, electromagnetic warfare, electronics research, electronic techniques, flight control, flight mechanics, geophysics, geophysics research, human performance, intelligence techniques, materials, materials research, mechanics research, navigation and guidance, nuclear warfare, propulsion, propulsion research,



Pershing Service Tower at Cape Canaveral

Pershing missile service tower at Cape Canaveral, Fla., is almost completed. Complex comprises a two-story blockhouse with 8-ft.-thick concrete-dirt roof, two launch pads with service towers, missile installation and checkout building, and helicopter parking apron. The tactical range missile is being developed by Martin Co. for Army.

Cessna-Holste Deal

Paris—Avions Max Holste, Reims, France, and Cessna Aircraft are discussing exchange of license rights. Cessna reportedly is interested in manufacturing and U. S. sales rights of Max Holste's feeder airliner, the MH-250 Super-Broussard (AW Jan. 25, p. 87). Twin-turbine, 23-passenger aircraft is slated to make its first flight this spring. Holste, in turn, would acquire similar rights on Cessna aircraft for West Europe.

In another transaction, Cessna shortly will begin negotiations with Potez-Air Fouga on ordering 400 of the French company's new 105-hp. four-cylinder engine.

Potez engine is interchangeable with the Continental C90. Potez has built 10 prototypes of the engine and recently had it certified at 105 hp. Originally, the engine was certified at 90 hp. at 2,550 rpm. Maximum cruising power is 68 hp. at 2,325 rpm. (AW July 6, p. 117).

Potez will market both the 90 hp. version and the 105 hp. version. Price of the Potez engine is not yet set, although it is likely to be around $1,600 FOB. On its possible order for 400, Cessna asked Potez if the order could be filled at a rate of 40 engines monthly. Henry Potez told Aviation Week he expected to begin production run on the engine next fall at a rate of 50 per month.

protection and sustenance of personnel, reconnaissance, secondary power, support equipment techniques, surveillance techniques, vehicle defense, weapon fire control, hypothetical systems conception, synthesis and analysis, economic science, political and social science and missile test ranges.

Under each of these 33 headings there may be up to 25 subheadings, each with a code number.

Indicate Code Number

Each engineer and scientist entered in the ARDC Cate register will indicate by code number his primary effort and his secondary area of effort. Then, he will write a maximum of six words which best describe the nature of his current work.

For example, one Air Force scientist at Cambridge Research Center lists code number 1305 as his primary effort. A reference to the Project Cate "vocabulary handbook" indicates that this deals with experimental and theoretical techniques for geophysics research. Then, under descriptive words, this scientist lists: infrared, spectroscopy, relaxation, phenomena, cloud and dispersion. For related effort category, scientist listed number 1302 (lower atmosphere) and listed the following descriptive words: background, infrared, atmosphere, transmission, radiation and ozone.

These descriptive words are subsequently coded and used by Project Cate office when attempting to locate a specialist in an unusual field, or with an unusual combination of talents.

The Project Cate vocabulary handbook lists about 2,700 descriptive words that have been developed by preliminary research and actual experience during the program's trial run. ARDC, however, does not insist that a scientist select one of these to describe his work. Instead, it plans to add to the existing vocabulary as scientists use new words to describe their efforts.

Beginning next month, Col. Vann and other Project Cate personnel will hold seminars in New York, Boston, Philadelphia, Washington, Chicago, Los Angeles, San Francisco and other major cities to brief industry on the program's operation. ARDC also has prepared 500 copies of a sound movie describing the operation of the program. These are available for loan to industry.

ARDC will encourage industry to report on company-sponsored programs which may be considered proprietary with the assurance that such information will be used solely for Air Force purposes and will not be released to other companies, if competitive secrecy is desired, according to Col. Vann.

Col. Vann says that ARDC hopes to have at least 50% of its industry cards back by early summer, with 80% in by the end of the year. Project Cate, begun as an ARDC headquarters program, was recently transferred to the newly formed Air Force Research Division. Idea for Project Cate is credited to Brig. Gen. B. G. Holzman, new AFRD commander, and Maj. Gen. Marvin Demler, USAF director of research and development.

Companies seeking additional information on Project Cate may write to Lt. Col. James Vann, AFRD, Project Cate, Andrews AFB, Washington 25, D. C.

Swiss Team Inspects Raytheon Hawk Missile

Geneva—Swiss air force team is visiting the United States to study the Raytheon Hawk missile and its possible adoption for defense against low-flying aircraft.

Swiss military earlier requested data through channels, but received only a single unclassified sales brochure from Raytheon. Now the air force has made an official request to Northrop Corp. for presentation but presumably the company has to get clearance to make a presentation anywhere above a completely unclassified level.

Pershing Test Pads Readied at Canaveral

Cape Canaveral, Fla.—Construction of the $2.46 million launching complex for the Army-Martin Pershing missile (see p. 32) is virtually complete and construction of two blockhouses, two ground-level launching pads and two silo launchers for the Air Force SM-80 Minuteman will be finished.

Launch complex for the NASA Saturn space vehicle is due for completion early next year. So far, $10,908,000 in construction contracts has been awarded. Saturn will use a 305-ft. tower serving two launching pads.

Launch complex 36, which has been designated the Space Systems Complex, is expected to be completed by mid-year. It will be used for firings of the Convair Atlas-Centaur for both USAF and the National Aeronautics and Space Administration. This complex was intended for the NASA-Convair Vega space vehicle before that project was canceled last December. The Convair-Lockheed Atlas-Agena, which will carry out most of the Vega missions, will now be fired from one of the four original Atlas pads. It will be used by both USAF and NASA.

Two hardened sites for launching of the USAF-Martin Mace cruise missile are to be completed this spring, and the Convair Azusa II impact predictor now is being given a final checkout. It is expected to be operational within the next few months and will be able to determine the position of a missile within one-tenth of a foot at a distance of several hundred miles.

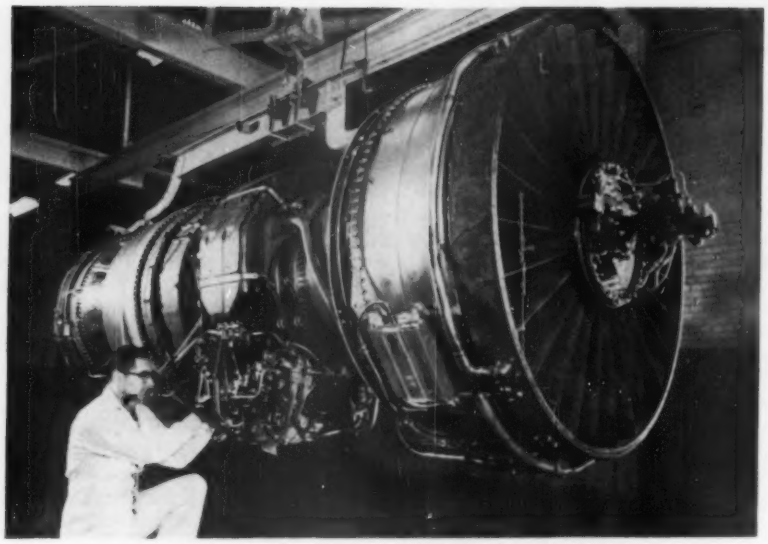
Minuteman blockhouses will be 50 ft. in diameter with four-foot thick walls. A total of $6,605,000 in construction contracts has been awarded.

'Silent' Satellite

Washington — Unidentified "silent" satellite traveling in an elliptical, near-polar orbit has been tracked for "some time" by U. S. space surveillance stations. Defense Department said last week it "may be of Soviet origin."

Initial theory was that the object, which is slightly smaller than the 19-ft. second stage of the U. S. Discoverer launcher and emits no detectable radio signals, might be a stage of the Soviet vehicle that launched the lunar photographic satellite. Defense officials late last week said privately, however, that it is "premature to conclude absolutely what the nature of this is."

Other theories are that it is a Soviet reconnaissance satellite that transmits only over Russia, or that it is a Soviet satellite that was partially unsuccessful and, therefore, not announced by Russia.



P&W JT3Ds for Boeing B-52H

First four Pratt & Whitney JT3D turbofan engines for use in the Boeing B-25H missile bomber (AW Feb. 8, p. 33) have arrived at Boeing Airplane Co.'s Wichita Division plant. Military designation will be TF33; thrust is 16,000 lb. and specific fuel consumption is .61. The engine is based on the J57.

NASA Asks Hydrogen Engine Bid

Washington—National Aeronautics and Space Administration will formally ask for bids this week on its new 200,000 lb. thrust liquid hydrogen-liquid oxygen engine, and the agency expects to choose a contractor within three months.

Formal request for bids follows a technical briefing of seven interested companies (AW Feb. 8, p. 28), and the bids will be due Mar. 14. Evaluation of the bids is expected to be completed by early May, and NASA will then choose a contractor to develop the engine.

Hydrogen engine development program will have to meet a schedule calling for preliminary flight rating test within three years. Although the eventual potential of the engine is to be 200,000 lb. thrust, it will be required only to meet a 165,000 lb. rating within this three year period.

Single Chamber

This hydrogen engine, which will be used in upper stages of advanced Saturn vehicles, will be a single chamber engine which can be used singly or clustered in groups of two and four. NASA has set diameter limits on the engine, but there is no limit on length. It must be designed for easy installation of a start-restart system.

NASA stressed reliability in its technical briefing, and companies have been told to hold to a minimum any requests for financial support of new facilities for the engine program. The contractor will be required to conduct simulated high altitude tests of the engine in a government facility. Arnold Engineering Development Center would seem the most likely site for such testing.

The hydrogen engine development program is slated for $16 million in Fiscal 1961, plus any money NASA can make available from its Fiscal 1960 budget. Since a contractor will not be chosen until the current fiscal year is nearly over, funding problems shouldn't be severe.

Second Stage

Hydrogen engine will be used in the C-2 and C-3 versions of the Saturn vehicle. Earlier C-1 version will use a modified Centaur vehicle with two Pratt & Whitney XLR-115, 15,000 lb. thrust hydrogen engines as a third stage. Second stage will be powered by four of an improved version of the XLR-115 which will develop 20,000 lb. NASA is expected to choose a contractor for this second stage about Apr. 1.

Discussing the various versions of the Saturn vehicle, Wernher von Braun, director of Army Ballistic Missile Agency's Development Operations Division, has said the C-1 vehicle will be able to put a payload weighing from 23,000 to 25,000 lb. into orbit, with payload weight depending on the altitude of the orbit. He expects the C-2 Saturn vehicle to be able to put 45,000 lb. into orbit, send two men around the moon or launch radio equipment for a Mars or Venus landing.

Nose Cone Separation Halts Titan Test Flight

Washington—Air Force Martin Titan test missile C-4 disintegrated in flight Feb. 5 after the experimental nose cone tore off and damaged both stages.

Although the exact cause of the premature nose cone separation is not known, fastening between the cone and the second stage is being strengthened in later missiles as a precaution.

This was the first Titan shot in which separation of the nose cone was to have been attempted. Recovery of a data capsule ejected from the cone also was to have been tried. The Avco cone was a scaled-down, experimental nose having the same configuration as the cone on the Titan C-3, which exploded on its pad Dec. 12. All Titans in the C series will carry similar cones.

The flight was the first launching from Pad 16 since it was damaged in the December explosion. The C-4 was the first Titan that has followed its entire schedule from factory through static tests and to launching without a delay prior to launching or an automatic shutdown of its first stage engines in an attempted launching. It would have been the second flight test of second stage ignition and propulsion.

C-4 flew perfectly for 52 sec. before the nose cone ripped off, damaging the sides of both stages and leaving the front end of the second stage open to the airstream. Structural damage, fire and explosion destroyed the first stage. The second stage broke away and continued to fly some distance on momentum, burning at both ends. Second stage engine was not intentionally ignited and the safety destruct system was not actuated on either stage.

Titan flew earlier in the same week on its first successful test of second stage propulsion (AW Feb. 8, p. 30).

Impact Locator Systems Developed by Bell Labs

New York—Bell Telephone Laboratories has developed two types of underwater detection systems which locate the impact point of a ballistic missile nose cone when it hits the surface of the ocean, and they are now in operation on the Atlantic Missile Range and are being installed on the Pacific Missile Range.

One system, which detects impact point location from the noise created by impact, employs five hydrophones (sonar receivers) arranged in a pentagonal configuration with a sixth receiver in the center. The network is connected by submarine cable to shore stations which measure time delay between receipt of impact sound at three

or more of the hydrophones. Several such installations are now in operation in the Atlantic, including one near Ascension Island.

The second locating system makes use of a sofar bomb which is ejected by the re-entering vehicle and explodes under water near the impact point. A series of hydrophones, usually located in pairs and spaced over a wide area with cable interconnections to shore stations, can obtain an acoustic fix by measuring time delay in receipt of the sound of the explosion. Detection ranges up to several thousand miles are possible. Systems were installed by Western Electric Co.

GE Will Produce Marine Gas Turbines

General Electric, in a move to diversify its turbine engine product line, will produce gas turbines for marine and industrial applications.

Initial turbine models include a 20,000-shp. version of the J79, a 900-shp. modification of the T58 and a 75-shp. turbine imported from the BMW works, Munich, West Germany.

First application for General Electric's large turbine will be the main propulsion unit for Dynamic Development Corp.'s hydrofoil seacraft (AW Feb. 1, p. 42).

This engine, the Model 240, will be rated at 20,500 shp. for a maximum of 5 min. and will have a continuous rating of 18,300 shp. The 5,500 lb. Model 240 is slated to be delivered to the Dynamic Development Corp., a Grumman subsidiary, for installation in late 1960. Sea trials of the hydrofoil craft are scheduled for the spring of 1961.

The 900-hp. T58 derivative is designated the Model 720 (Model 722 is intended for natural gas fuel). This turbine also will be employed in the 80-ton hydrofoil craft. This secondary powerplant will be used to maneuver the craft at low speeds when the displacement hull is in the water. It currently is powering a 24-ft. experimental hydrofoil craft.

Commercial applications for the Model 720/722 include powering a fracturing pump in the petroleum industry and as a compressor drive in natural gas pipeline pumping station.

The BMW 6002 turbine engine will be imported by General Electric in approximately six months and, it is hoped, eventually produced here under license. The engine is now rated at 75 hp., but General Electric expects to market the engine at power levels from 100 hp. on down.

The Model 6002 is 28 in. long and 18 in. in diameter; its weight is 130 lb. with gearbox.

C-130 Boundary Layer Tested

Lockheed NC-130B boundary layer control testbed made its first flight last week at Marietta, Ga. Testbed aircraft will be taxied and flown without using the boundary layer system until the crew is familiar with its modified controls, then the BLC will be tested at high altitude. If these tests are successful, the NC-130B will use the system on short takeoffs and landings. Testbed aircraft uses two podded Allison T56 turbines to drive the BLC system, but the production model will use four small turbojet engines. Aircraft was bailed to Lockheed after the Air Force terminated financial support of the project, and the company will finish the program with its own funds.

News Digest

Export-Import Bank has approved a loan of $6.9 million to Varig, Brazilian airline, to cover the major portion of the purchase of two Boeing 707 intercontinental transports powered with Rolls-Royce Conway bypass engines. Balance of the purchase price, covering airframe, airframe spares and ground equipment, is being financed jointly by Boeing and Varig. Engines are being purchased with European financial assistance.

Four-point U.S. proposal for a nuclear test ban, including explosions in space, was presented to the Soviet Union and Great Britain last week. Proposal would ban all nuclear weapons tests in the atmosphere, oceans, "those regions of space where effective controls can now be agreed to" and "beneath the surface of the earth which can be monitored."

Joint Communications

Washington—Defense Department announced plans last week to establish a joint military long-range communications system through integration and expansion of separate service facilities, as predicted by Aviation Week (Aug. 10, p. 23). New joint communications network, as now planned, will not include weapon control and tactical communication system, such as Strategic Air Command and Air Defense Command control systems. Individual services have opposed the plan for fear they would lose these important mission lifelines. Joint system will be developed on an evolutionary basis over the next decade.

Japanese government is preparing to place orders with the U. S. for 42 Convair Tartar guided missiles, two launchers and a firing command device to be installed on a new defense vessel of the Sea Self-Defense Force. Missiles cost $100,000 each. The vessel is scheduled to be launched in 1963.

Stanford University disclosed last week that it made first reported radar contact with the sun last April by bouncing a 26 mc. signal off the sun's corona using radar built for ionspheric studies.

Japan Air Lines is sending a survey team this month to Convair's San Diego plant to study the Convair 880 medium-range transport for use on routes in Southeast Asia and to Europe. The airline is in the market for three medium-range jets for delivery within 16 months. Japan Air Lines also is studying the Caravelle 6, Comet 4C, Boeing 720 and 720B and the Convair 600/30.

Edward J. Ryan, North American Aviation corporate director of public relations, died in Los Angeles earlier this month. Ryan, 52, joined North American in 1944 and become director of public relations in 1948. NAA News Bureau Manager William E. Van Dyke will succeed Ryan.

British Minister of Aviation Duncan Sandys said last week that Britain is making design modifications to military rockets to be used as space vehicles. This was the first official announcement that Britain plans to use its own launchers in addition to those offered by the U. S. He undoubtedly had in mind the de Havilland Blue Streak and Saunders-Roe Black Knight, probably in combination (AW Sept. 14, p. 108).

AIR TRANSPORT

New Plan May End Airline-MATS Fight

Defense program approved by President would reduce channel traffic, provide longer-term contracts.

By L. L. Doty

Washington—President Eisenhower last week approved a program calling for a revision of Military Air Transport Service which, if implemented, could bring to an end the long drawn-out battle between airlines and MATS.

The program, which was contained in a study of MATS prepared for the President by the Defense Department (AW Jan. 18, p. 43), included these points, which historically have been the chief sources of contention:

• **MATS channel traffic**, which is moved over fixed routes, will be "reduced on an orderly basis, consistent with assured airlift capability at reasonable cost . . ." MATS will be equipped to meet military "hard-core" and other requirements that cannot be handled adequately by commercial carriers.

• **Policies of procuring airlift** from the commercial carriers in overseas operations are "to be better adapted to long-range Defense Department requirements." This includes entering into longer term contracts with carriers, increasing commercial participation to include traffic other than channel traffic, and giving preference to those carriers which are committed to the Civil Air Reserve Fleet, whose facilities are most suited to defense emergency needs and which show willingness to "acquire uncompromised cargo aircraft."

The program calls for joint military-civil financial backing of the development of a turbine-powered cargo aircraft that will be compatible with the operation of each group. It also included a condition that increased use of commercial carriers should be keyed to the introduction of "modern, economical long-range aircraft" by the carriers and to the orientation of MATS to its "hard-core function."

Since timing of full implementation of the program hinges on the development and operation of an all-cargo, turbine-powered aircraft, some clue as to when the program may be in full swing is found in recent budget requests by the Air Force.

USAF is now asking for $50 million for the development and design of "a truly optimum cargo aircraft" which, based on July 1 approval, will be placed into the first MATS operational squadron July 1, 1964. Second and third squadrons are scheduled to become operational during Fiscal 1965.

Other points in the program endorsed by the President are:

• **Modernization of MATS** hard-core airlift capability is to be undertaken in "an orderly manner consistent with" military requirements. Hard-core functions are defined as special military deployments involving nuclear retaliatory forces, Strategic Air Command post-strike recovery mission, tactical deployments, movement of missiles and special munitions.

• **Purchase loan guarantee** legislation, if proposed, should contain provisions ensuring "immediate availability of cargo aircraft . . . to meet military and mobilization requirements."

• **Equipping reserve and National** Guard units with transports declared excess by MATS to augment MATS in an emergency should be considered.

• **Civil Reserve Air Fleet** role should be re-examined.

Defense Study

The Defense Department study admitted that the airline type of operation conducted by MATS is the "genesis of the bulk of criticism" aimed at MATS and added:

"The feeling against the MATS airline type of operation has become so strong of late as to constitute an effective block against the modernization of military airlift capability."

On this point, the study found that airlift capacity assigned to MATS is adequate to meet the hard-core requirements of a general war but noted that it is "seriously deficient quality-wise and greatly dependent on the availability of intermediate island bases."

It said the C-133 is the only modern aircraft in MATS, with the remainder of the fleet containing only piston-engine aircraft, and concluded:

"The over-all cargo airlift situation is serious and unless action is taken to modernize and expand the national cargo capability, both military and commercial, effective airlift support cannot be assured the armed forces. Further, unless cargo capability is modernized and expanded, the Department of Defense and the nation will continue to be denied efficient and economical airlift."

Throughout the study, urgent calls for modernization of commercial cargo airlift were made. The study said that the amount of commercial airlift procured by MATS has increased from $29.1 million in Fiscal 1954 to $70.4 million in Fiscal 1959. Estimated expenditures in Fiscal 1960 are expected to reach $85 million.

The report said that, although MATS has a total of 1,245 aircraft assigned to it, only 511 are "in the common user or strategic airlift fleet." The majority of the remainder, the study said, is not even "transport configured." It noted that the C-124, the "workhorse of the military fleet," is rapidly approaching obsolescence.

The study charged that airlines can accommodate only a small percentage of military traffic that can be handled by air and added:

"There are no aircraft in the commercial carrier industry which were originally designed as cargo carriers. All commercial cargo aircraft have the serious disadvantage of high floor and side door loading. For many types of military cargo they are useless. None has the required payload-range capabilities."

The study reported that, while there are indications that commercial airlines are willing to undertake some modernization of cargo fleets based on the potential of the commercial air freight market, "there is a belief widely held within the government that a diversion of sizable quantities of government traffic would greatly accelerate this modernization . . ."

On this point, it concluded that assurances of government traffic to the airlines would assist the carriers in the planning and financing of re-equipment programs. It said a "major portion" of routine logistic traffic should be assigned to the airlines "subject to reasonable prices, availability in emergencies and the assurance of modernization."

In commenting on the nine-point program, Stuart G. Tipton, president of the Air Transport Assn., said, "the recommendations contained in the report . . . can, if properly carried out, provide the nation with a vastly improved airlift." Early industry reaction to the report was similarly favorable although there was some doubt expressed by not a few airline officials here that the program would ever reach the full implementation proposed in the study.

National Takes Delivery of Its First DC-8

National Airlines has taken delivery of the first of three Douglas DC-8s. The 119-passenger jet transport will undergo acceptance checks at Miami and will be used for training flight and ground crews before entering service between New York and Miami.

Douglas Will Sell and Service Caravelles

New York—Douglas Aircraft Co. has cast its lot with the twin-jet Sud Caravelle as a short-haul commercial transport contender, ending any prospects for production of the Douglas DC-9.

Sales prospects of the French jet climbed sharply last week as Douglas and Sud Aviation reached an agreement covering U.S. sales and service and possible production of the airplane (AW Jan. 11, p. 42).

The agreement announced here jointly by Douglas and Sud covers "broad mutual product support" for the Caravelle and Douglas DC-8, and for possible other long-range projects either company may develop. Under the Caravelle arrangement, Douglas will provide sales support, customer service and parts support, and customer ground and flight training. Douglas also gets the right to manufacture the Caravelle, and will represent Sud in various territories throughout the world in "all matters affecting the Caravelle transport."

Promoting the Caravelle and DC-8 as a complementary combination, the two manufacturers will provide worldwide sales support for each other.

The agreement is believed to have virtually clinched the most likely U.S. Caravelle prospect—United Air Lines—whose order of 20 with option for 10 is considered imminent. Sud last week would not comment officially on the United reports except to say that a sale was still under negotiation.

A spokesman said, however, that the aircraft are being built for United and if the contract isn't signed, they will be sold to someone else.

A previous stumbling block to the United sale was the airline's insistence that trade-in of 20 piston-engined Douglas DC-6Bs and DC-7s be included in the deal (AW Jan. 4, p. 32). This consideration may have swung Sud to Douglas as a partner instead of Convair or Boeing, which also were discussing Caravelle plans with the French manufacturer.

United, or any other U.S. airline customer, now would sign with Douglas instead of Sud and this should simplify after-sale service and similar contract agreements.

Donald Douglas, Jr., president of Douglas Aircraft, said here last week that the other aspect of the agreement—cooperation on other future projects—was as important as the Caravelle arrangement.

For a future program which could include product diversification, it is important to his company to have access to the European common market, according to Douglas. Sud is in a strong position both in the common market and in Air Union, Douglas said.

Delivery Dates

Regarding the Caravelle agreement, Douglas said his company could produce the jet transport for delivery within two years. Sud is offering the Caravelle with Mk. 6 Rolls-Royce Avon turbojet engines (AW Dec. 21, p. 28), including thrust reversers, for April, 1961. Production at the French factory is now at a rate of four planes a month.

If Douglas produces the Caravelle, growth modifications would be incorporated and a choice of engines—Rolls Royce or a U.S. make—would be offered. Douglas, which in any case will provide Sud with whatever production and technical background the French manufacturer may want, will work with Sud on modification plans and may come up with modifications of its own for French and/or American production.

Front-runner among U.S. engine manufacturers for a possible Caravelle powerplant would appear to be General Electric. That company has ordered a Caravelle for July delivery and will test its aft-fan engine in the airplane.

If Douglas decides to produce the Caravelle, it would provide the manufacturer with a use for its Santa Monica, Calif., plant, which is too small for current generation U.S. transport production.

The plant recently has been used as a warehouse.

Donald Douglas, Jr., at the joint conference here last week with Sud Chairman Georges Hereil, indicated that the agreement ended any plans for the short-range Douglas DC-9.

The Douglas company decided, he said, to make the arrangement—first as a sales and service agency and then possibly as a producer of the Caravelle—to avoid "stretching thin" his company's finances by investing heavily in DC-9 development. Instead, with the Caravelle arrangement, Douglas can concentrate on financing further modifications and versions of the DC-8.

Douglas said his company's acceptance of a two-engine configuration was a reversal of an earlier belief that four engines were needed to attract U.S. jet customers. But jet engines have shown superior reliability in their service experience, he said, and the two-engined airplane can provide the lowest airplane mile cost, which counts more than seat mile cost in short range operation. Public acceptance of the Caravelle, he added, has been clearly demonstrated in airline service.

Hereil said he believes U.S. carriers will have more confidence in after-sales service and supply with Douglas handling that end in this country.

According to the Sud official, the Caravelle will sell for about $3 million here. Import duty amounts to 12.5% of the price. He could not estimate the breakeven point of Caravelle sales, Hereil said. His company, which he said lost about $9 million last year, should break back into the black in

1961, the chairman estimated.

Douglas estimated the U.S. market for the airplane at about 300 orders in the next three or four years. Regarding possible aid to U.S. customers in financing Caravelle purchases, Douglas said his company would study each case, as is done with the DC-8, and offer help in some cases.

The Douglas official would not set a minimum number of airplane orders his company would consider necessary to set up Caravelle production. Asked if 30—the probable total involved in a United order with options—was a reasonable number, Douglas acknowledged "that would make life interesting," but indications were that 50 or 60 would be closer to the decisive point.

Project Studies

Regarding diversification plans, Douglas said his company and Sud have common problems and would work together in developing other projects. Douglas recently has strengthened its study organization in this respect, he said, and has undertaken broad research in the diversification area. Thinking is for medium, rather than mass, production items with 100 to 1,000 units. Goal would be to sell the entire organization, including tooling as well as manufacturing. The agreement with Sud would not preclude either company working with others in special cases.

Hereil said Sud's agreement with Republic Aviation for U.S. handling of the Alouette helicopter still stands, and that other possible helicopter projects also would come under the Republic commitment.

Sud's present four-a-month Caravelle production rate was reached in December, four months ahead of schedule. Louis Giusta, Sud managing director, told AVIATION WEEK in Paris that the rate could go to five a month without adding a production line. With a U.S. manufacturer sharing the work, the monthly total could go to seven, he said. Caravelle parts are made in 10 different factories around France, and at Fiat, which builds about 8% of the aircraft. Some 66% of Sud's employes work on the Caravelle. All final assembly is done at Toulouse, where the daily work schedule is now 18 hr.

Future Plans

At the New York conference, Douglas answered some questions concerning his company and the DC-8:

• **Cargo version of the DC-8** is being studied along with a total systems study in the cargo field. Among the questions as to possible configuration of a cargo DC-8 is where the powerplant development will level off; previous estimated limit was around 20,000 lb. thrust, but is now up to 24,000 lb. An all-cargo version of the Caravelle, along with "every possible configuration," will be studied in cooperation with Sud.

• **Speed of the transcontinental** DC-8 "is not as slow as advertised by all our friends." United, according to Douglas, now is averaging two minutes less than competitors in its jet schedules. Modifications and improvements now under way are related primarily to the long-range versions of the DC-8, and international customers have agreed to "some slight delay" in delivery. There has been some drag increase problem in the long-range, slower speed regime, but fixes are under way.

• **Douglas is "spending some money"** on vertical takeoff and land research. Scale models have been built but not actual airframe.

• **Mach 3 transport production** depends entirely on how much money goes into development, and practically nothing is now being spent in this area. On the other hand, billions have gone into rocket development and conceivably the next commercial technological jump could involve rocket propulsion.

• **Douglas company's information** on the Caravelle crash in Turkey (AW Jan. 25, p. 36) indicates the pilot was low in a localizer descent and then flew into an unmarked hill.

Swing-Tail Turbofan Cargo Plane Proposed for MATS by Boeing

Washington—Reduced operating costs and improved performance capabilities in cargo operations on Military Air Transport Service routes through the introduction of a high-speed, large capacity cargo aircraft powered by turbofan engines have been outlined in an economic evaluation study prepared for Boeing Airplane Co.

The study, prepared by Prof. Stanley Brewer of the University of Washington, makes a detailed economic comparison of the proposed Boeing turbofan all-cargo transport with six aircraft currently operated by MATS. The aircraft, an all-cargo, swing-tail transport powered by four Pratt & Whitney JT3D turbofan engines (see picture, p. 34), is a cargo version of the Boeing 735 intercontinental turbofan transport.

Brewer outlined these factors in his study:

• **Turbofan cargo plane** can operate at a work unit cost lower than any cargo transport now in service.

• **At load factors of 50%** or above, the turbofan aircraft "comes nearer to covering total operating costs over the routes evaluated than any other transport." Since the plane is designed as a long-haul, large capacity transport, economic advantages are not "great" at low load factors.

• **Major advantages** are reductions in skilled and unskilled manpower necessary to achieve a given lift and a reduction in ton-mile costs for transporting cargo.

• **Unit costs** will be increased and revenue earning capability will be cut if average shipment weighs less than 12.5 lb. per cu. ft. Plane is not designed to carry economically any cargo which occupies a large volume of space in proportion to weight.

Aircraft used in the comparative study were the C-133B, C-124C, C-121C, C-118, C-97C and the C-54. Economic factors involved in operating these aircraft were analyzed over 42 MATS routes selected at random. Costs were based on the Air Transport Assn. formula, and revenue-producing capability of each transport was based on MATS common user tariff rate. Using these factors in the analysis, the study reached this conclusion:

"For all routes studied and at all of the assumed load factors, the cargo-jet and the C-133B are the most profitable airplanes insofar as marginal revenue is concerned."

On the subject of work capacity and fleet investment, the report found that a turbofan fleet would call for "less investment and fewer airplanes to perform a given workload than any of the other transports."

Actual cost of each of the cargo aircraft has been set at $5.8 million. Certificated gross weight of the airplane will be 316,000 lb. and cargo weight capacity will be 106,000 lb. with a maximum payload range of 2,365 mi.

With a payload of 52,000 lb., the airplane can operate 4,500 mi. nonstop. At an annual utilization of 3,000 hr., the Boeing transport is capable of producing 60 million ton-miles of cargo-carrying capacity. Direct operating costs, computed by the ATA formula, reach a minimum of 4.47 cents per ton-mile.

In comparing operating costs of the turbofan aircraft with the six other transports used in the study, the report said:

"Using the straight ATA formula, the nautical-ton-mile costs (of the six airplanes) range from 6.668 cents to more than 12 cents. Other than the C-133B, which appears to be the most economical of the present fleet on the basis of cost assumptions made, none of the other aircraft shows an optimum cost less than 8¼ cents per nautical-ton-mile."

Using a formula based on estimated

military costs, the study found the C-133B with the lowest cost and the C-54 with the highest cost. The report pointed out that cost figures should be interpreted in the "light of particular routes inasmuch as the optimum range for many of the craft is lower than trip segment-lengths that must be flown nonstop."

The study warned that "no serious attempt should be made to compare costs of MATS peacetime airlift operations with those of commercial carriers." However, at MATS tariff rates on 42 routes at 100, 80 and 70% load factors, the study concluded that five of the aircraft studied should be ranked this way with respect to profitability: the turbofan was ranked first, the C-133B was second and the C-124C, C-121C, C-97C followed in that order.

C-54 Operations

In its analysis of workload and manpower, the report noted that the C-54 was "probably the most efficient cargo-carrying airplane of World War II." This transport, according to the study, could produce 1,100 ton-miles per flight crew hour or 217 ton-miles per direct man-hour.

In contrast, the C-133B—in MATS operation—will produce 8,555 ton-miles per flight crew-hour or 1,711 ton-miles per direct man-hour. The proposed Boeing turbofan freighter, with the same assumptions, will develop 16,120 ton-miles per crew-hour or 3,224 ton-miles per man-hour.

The study found that, at a 100% load factor and 2,190 hr. utilization annually, each crew member assigned to the turbofan aircraft would generate an average of 4,600 ton-miles per hour of flight. A basic crew of five men would produce 23,000 ton-miles per flight hour.

Loading System

The proposed aircraft also includes plans for a mechanized "air-floor" (palletized) loading system. The system will reduce time required for loading and unloading to 75 min. with two mechanical loaders and six men. By cutting turnaround time and increasing utilization of a single airplane by some 3 hr., as much as $10,000 additional gross profit per trip could be earned at rates published by MATS.

The report found, however, that the weight and volume sacrifice results from using the air-floor system since its installation would reduce payload by 3,500 lb. and cut available volume capacity by 320 cu. ft. Nevertheless, the report concluded that such losses would be offset by the increase in daily utilization, termed "extremely important in the light of MATS emergency mission requirements."

Opposition From Major Airlines May Cripple Cargo Loan Plan

Washington—Opposition of major airlines may cripple the prospects for legislation authorizing government-guaranteed loans to spur the development and purchase of an advanced cargo aircraft.

Sponsored by Sen. A. S. Mike Monroney (D.-Okla.) and Sen. Stuart Symington (D.-Mo.), the bill provides for government guarantee of loans up to $75 million for an individual airline for the purchase of cargo aircraft approved by the Department of Defense and the Federal Aviation Agency (AW Jan. 18, p. 43). It has the support of Defense, FAA and the Civil Aeronautics Board as a stimulant to the development of economical cargo airlift which would be available to the armed services in an emergency.

At hearings before Monroney's Senate Aviation subcommittee last week, FAA Administrator E. R. Quesada estimated that the legislation would result in the purchase of over $600 million in new cargo aircraft.

The qualifications outlined by Defense Department and FAA, would be:

• **User rate** of 10 to 13 cents a ton-mile, or about half that of the current passenger-type aircraft which have been converted for cargo use. This cost reduction is considered essential to attract business from surface carriers.

• **A 4,000-mi. range** with a 40,000 lb. payload, and a 400 to 500 mph. speed.

The CL-44 built by Canadair, Ltd., a subsidiary of General Dynamics Corp., meets the operating cost requirement. Quesada said that no existing aircraft meets both the operating cost and performance requirements. He reported that in view of the current state of the art, no research would be required for manufacture of the proposed aircraft.

Vernon A. Johnson, vice president of Lockheed Aircraft Corp., reported to the subcommittee that, with firm orders for 100 planes, his company could produce an all-cargo turboprop or jet aircraft in 28 to 30 months. The cost of the turboprop was estimated at $4.4 million, the jet at $6 million.

Subcommittee opposition to the Monroney-Symington legislation came from Sen. Clair Engle (D.-Calif.) and Sen. Andrew Schoeppel (R.-Kan.). They put on record several airline statements to CAB opposing the plan, including:

• **American Airlines** told CAB: "We are confident that funds from private sources can be raised if we can make an adequate showing that the fleet to be acquired will operate with profit. The availability of government-guaranteed loans would not increase our interest in the purchase of cargo aircraft." Braniff Airways and Capital Airlines concurred in American's statement.

• **Eastern Air Lines,** in a similar vein, said that "the mere fact that the loan guarantee is available would not create an air cargo market. . . ."

• **Flying Tiger Line,** which has purchased 16 Canadair CL-44s under a Canadian government-guaranteed loan, reported to CAB that "if the purpose of government guarantee is but a form of subsidy, Flying Tiger, for its part, wants none of it."

• **Pan American Airways** said that "the government-guaranteed loan program is in no way essential. . . ."

The carriers which endorsed the guaranteed loan proposal included Northwest Airlines, National Airlines, Aerovias Sud Americana, Slick Airways, and members of Independent Airlines Assn.

CAB Chairman James R. Durfee told the subcommittee that 1957 legislation providing government-guaranteed loans to local service lines has stimulated the purchase of 43 aircraft, totaling $22.6 million. They include five helicopters, 10 Convair 340s and 28 Fairchild F-27s.

Quesada supported the measure from three viewpoints:

• **The need for an "uncompromised"** U. S. cargo plane to retain the nation's "relative" position in world commerce, particularly in view of developments now under way in England and Russia.

• **The requirement of the military** for cargo lift. "The military cargo fleet then could, and should be limited to meeting so-called 'hard core requirements'—be composed of aircraft which are specially designed to carry out-sized or special military cargo and perform uniquely military functions, and should be limited to the number needed for direct support of the execution of emergency war plans," Quesada said.

• **The desirability of bolstering** the airframe manufacturing industry, now confronted with dwindling employment. Quesada reported on "an existing and functioning and typical" company now employing 23,000. An FAA study showed that on the basis of known orders this firm can now expect, its employment will go down to 12,000 in 1961, to 4,000 in 1962, and to 1,500-2,000 in 1963.

Perkins McGuire, assistant secretary of defense for supply and logistics, testified that in MATS there "is not a single modern cargo aircraft in the fleet today."

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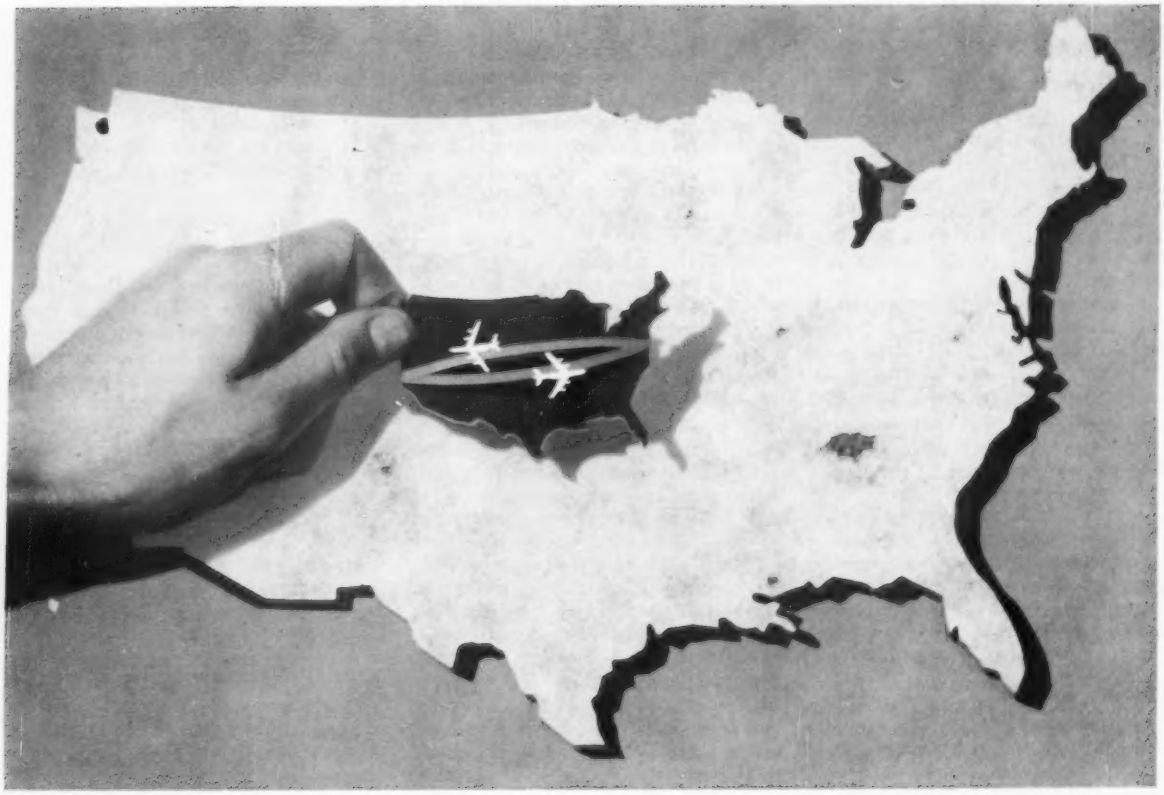

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Braniff May Buy 3 More Jets for 1961

New York—Braniff Airways is seriously considering purchase of three more jet transports for 1961 delivery and will decide soon between the Boeing 720 and the Convair 880.

Charles E. Beard, Braniff president, told the New York Society of Security Analysts here last week that he hoped the decision would be made by this week. It had become a difficult decision, he said, because of the potential advantages of each airplane.

Those he listed for the 720:

- **Parts interchangeability.** Based on inventory catalog, 85% of the parts of the 720 are interchangeable with those of Braniff's 707-227s now in operation or being delivered or are 55% interchangeable based on dollar value.
- **Engine similarity.** The Pratt & Whitney JT3 engines of the 720 are not interchangeable with the JT4s Braniff's 707s are equipped with, but the common design philosophy and manufacturer would mean fewer training problems. Also, cockpit similarity would ease pilot training. Braniff is not interested in turbofan powerplants.
- **Size and cabin configuration** similarity would make it easy to interchange the 720s with 707s on the line, thus giving the 720s great flexibility.

Those for the 880:

- **Lower initial cost.**
- **Lower seat mile cost.**

An intangible advantage might be added to this list as indicated by Beard's expression of admiration for the 880 as a "beautiful airplane." However, he also strongly praised the 707, pointing out that Braniff had experienced only two mechanical delays with the single 707 it has operated since December.

Beard said the new airplanes, if the delivery schedules in 1961 are worked out satisfactorily, can be bought out of cash flow without the need for any further financing. Braniff will reach its peak in depreciation charges this year, he pointed out, with the figure running $7-8 million.

Rotodyne Subsidy

London—Development of the Fairey Rotodyne VTOL will be subsidized by the British government up to $11.2 million, according to Duncan Sandys, minister of aviation.

Agreement has been reached with Westland Aircraft, Ltd., which moved to acquire Fairey Aviation (AW Feb. 8, p. 36). Grant was originally offered to Fairey, which turned it down (AW Dec. 14, p. 35). Recovery of government's money is hoped to result from eventual sales.

Lockheed Cargo Plan

Washington—Lockheed Aircraft Corp. is surveying the airline market in the process of setting a final configuration for a new turboprop cargo transport powered by Rolls-Royce Tyne engines.

Based on the Super Hercules design offered jointly to the airlines and the Air Force last year, the new transport will be aimed primarily at the airline market, and delivery is not expected to depend on military orders. This would indicate that Lockheed intends to invest a substantial amount of its own money in the project.

The projected Lockheed cargo transport will use an advanced version of the Tyne turboprop engine and will be equipped with de Havilland propellers.

Braniff's financing program involving sale of equity securities in 1955 and 1956 which raised approximately $16 million, long term loans from seven insurance companies of $40 million and internally generated capital has been ample for its current jet program without requiring use for this purpose of $10 million in short term bank credit that was also available.

Beard's discussion of prospects for Braniff sounded distinctly optimistic in the New York financial climate, which has seen airline stocks under pressure for the last six months.

He made no predictions of profits for this year, but he did use projections which gave 56% as the minimum load factor average Braniff is aiming for this year. On the basis of a 56% load factor, Braniff would show 1960 net earnings of approximately $3 million; on 57% load factor it would show earnings of $3¼ million and on 58% earnings of $3.9 million. This compares with net income for 1959 of $2½ million.

Goals for load factors in this area are based on addition of nonstop service not flown before and on widening of charter service. Braniff has not been able to accept many of the latter in the past because of equipment problems, he said.

Jet costs have been well below estimates, Beard said, and load factors on the jets have been running at the 60% level. Expected jet breakeven load factor domestically, he said, is 50% and internationally 45%.

Because of training requirements, it will be late April before all Braniff's four 707-227s will be in scheduled service. Jets will be used both on domestic and international routes and piston equipment will be stair-stepped; that is, Douglas DC-7Cs will replace DC-6s, DC-6s will replace Convair 340/440s and Convairs will replace DC-3s. Braniff's last three DC-3s (it was operating 23 a year ago) will be phased out in mid-May.

Beard sees no replacement for the Convairs even on the drawing boards at this time. Turbine conversions of the Convair will cost 18-20 cents a ton mile more to operate, he said, and there is no room for adding passenger space in the airplane to compensate for this, nor do Braniff's routes indicate a greater traffic potential for such equipment. Braniff's many short stage lengths also cut the potential speed advantage.

Some temporary excess capacity may develop this year as more jets are delivered, Beard said, but Braniff does not expect this problem to become serious. It is prepared for either eventuality, however, for he pointed out that a fully depreciated DC-6 does not cost much to ramp park if traffic is down nor does it have a high load factor requirement to operate profitably if the traffic is there.

Braniff will make a major effort this year to stimulate day coach travel. "We hear a lot about bringing fares down for the common man," Beard said, "but our experience has been that the common man prefers first class meals and service. By the middle of 1961 we will know whether the common man can be persuaded to fly coach on our routes through lower fares."

This year Braniff will fly 21% of its available seat miles with 707s and 24% with Lockheed Electras. Domestically, coach will average 30% of available seat miles, compared with 14% last year, and first class the other 70%. On international routes tourist class will be approximately 52% of available seat miles offered.

Domestic operations generated 89% of Braniff's 1959 total revenues of $74,246,651, Beard said. Losses on the international routes dropped from $269,600 in 1958 to $133,500 last year.

British Air Carrier Enters Bankruptcy

London—Independent Air Travel, Ltd., owner of the Viking aircraft which crashed at Southall, Middlesex (AW Dec. 14, p. 119), has gross liabilities of $789,723, it was revealed at the London Bankruptcy Court last week.

Liability for insurance of the crashed aircraft still is under dispute, and unless insurance money is received, unsecured creditors—who are owed $676,777—probably will get nothing, according to G. M. Haddon, senior assistant official receiver.

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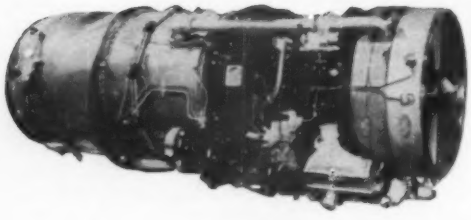
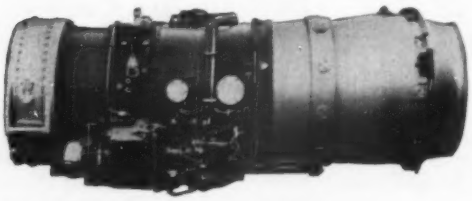
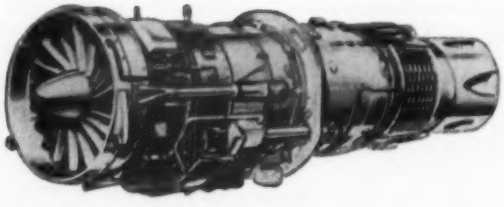


Conway by-pass jets will enter service this year in Boeing 707-420 and Douglas DC.8 jet airliners at 17,500 lb. guaranteed minimum thrust. The Civil Conway is being developed to powers over 20,000 lb. thrust with improved fuel consumption and will power the Vickers VC.10.

THE BY-PASS PRINCIPLE PROVED BY THE CONWAY IS NOW GENERALLY ACCEPTED AS THE CORRECT FORMULA FOR JET TRANSPORTS



The RB. 141 of 14,300 lb. thrust will power later versions of the Sud Aviation Caravelle.



The RB. 163 of 10,100 lb. thrust has been chosen to power the Airco DH.121.

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Flying Crane Considered for Commuters

By Robert H. Cook

Washington—Use of flying crane helicopters carrying passengers in detachable pods is under study by Federal Aviation Agency in its search for a practical means of solving the transportation problems of suburban commuters and of downtown-to-airport travel.

Flying crane approach is among the proposals for expanding the use of helicopters and VTOL and STOL aircraft which FAA is discussing in a national tour of industry, transport operators and communities under Project Hummingbird. This planning guidance project is being conducted by the FAA Plans and Requirements Division, and the group expects to report by the end of the year on how the growing capabilities of helicopter, VTOL and STOL flight can safely and economically be integrated into the aircraft pattern.

FAA has launched Project Hummingbird because the agency thinks the trend toward greater use of helicopters has clearly indicated that this type of air transportation is fast becoming one of its major areas of responsibility in the formulation of national aviation policy.

FAA has certificated 550 commercial helicopters, and FAA notes that there are three helicopter airlines in operation today and that the Civil Aeronautics Board has a current backlog of more than 80 applications for helicopter-type airlines, which the Board will not approve until industry can produce an aircraft capable of making at least a break-even operational cost record.

Supporting contentions that the helicopter is gaining new importance in air transportation, FAA points out that greater attention currently is being given VTOL aircraft because of the remote location of airline terminals, heavy growth of airline traffic, present runway restrictions and the gradual military shift from manned supersonic aircraft to missiles, causing aircraft manufacturers to explore new market potentials.

FAA feels that the state of the art in helicopter development has already outpaced regulatory progress. In the wake of New York Airways' order for Vertol 107s and Chicago Helicopter Airways' order for Sikorsky S-61s, FAA finds that it does not have firm rules for the certification of these aircraft or their crews. The agency recently inaugurated its own 24 hr. all-weather helicopter operation in the New York area to aid in the formulation of the necessary regulations, and the rules should be ready by the time these operators put their new aircraft into service by late 1961 or early 1962.

In a survey of the operational potential of helicopters, FAA says:

- **Airport-downtown service** is currently in operation, and ordering of new Vertol and Sikorsky turbine-powered aircraft may provide their operators with the first major breakthrough into a more profitable operation.
- **Short haul or feederline** operation is an untouched "bag of gold" which operators could tap, once navigational and traffic control systems and landing area complexes are acquired.
- **Business aircraft,** including air taxi operations, may get a significant boost from such developments as the Allison Model 250 engine, which weighs only 95 lb. and may sell for $6,000. Regarded by the project staff as a "terrific step forward," the group feels that adoption of the engine for multi-engine helicopter use could cause such aircraft to "come upon the scene like a thunderbolt and begin multiplying like rabbits."

FAA points out that the ideal weight/power ratio, permitting more economical operation, plus the added safety of an extra engine, would do much to settle the concern many cities now have over autorotation problems with single engine helicopters operating over city centers. It also will make instrument flight regulations operations in the small helicopter more practical, since the extra power would permit a strict vertical takeoff or landing through heavy fog conditions, following a vertical radio beam.

- **Commuter travel** is considered the most likely prospect for flying crane operations utilizing "people pods." For suburban commuters, FAA envisions a three-engine flying crane capable of lifting as much as 40,000 lb. of payload. Pods considered could be designed as buses, or even subway cars. Designed as a bus, the pod would cover a suburban area to gather passengers, then drive to the nearest heliport to be picked up by a flying crane. The crane would deposit the pod either at a downtown heliport or, in the case of subway design, at the end of the subway line.

Pods designed only for flying crane use could be stored between morning and afternoon rush hours, thus freeing the crane aircraft to transport cargo or do a variety of construction work.

Another version of the flying crane would use a crane and pod combination for an aerial limousine service between downtown areas and airports. Ticketing, reservation, baggage and all other services usually performed at the airport would be done in a complex of downtown terminal heliports constructed on rooftops. Mobile lounge-type pods would be designed so passengers could disembark directly from the pod into the waiting aircraft on the runway.

Actually, project officials said, a separate building would have to be constructed to carry out such a plan, although railroads have expressed an interest in the proposal by pointing out that all transportation facilities needed by the traveler are already present in railroad terminals which could be altered to include a heliport.

Getting the aircraft and pods to carry out this plan would not be difficult, FAA said, on the basis of talks with manufacturers, but the major problem will involve community cooperation in acquiring heliport sites.

Soviet Crane Proposal

Moscow—Soviet electric power officials are calling for development of a special high-capacity flying crane helicopter for use in building transmission lines in mountainous and roadless areas.

Soviet construction organizations stringing transmission lines in the Crimea and on the Kola Peninsula near Murmansk have been using single-rotor Mi-4s to carry fully-assembled metal supports weighing about one metric ton or sections of heavier supports. But the Mi-4's payload capacity is said to be inadequate for this work. Hints that a Russian flying crane helicopter will soon be available have been appearing with increasing frequency in the Soviet press.

Continental's Sales, Net Profits Increase

Continental Airlines recorded a 1959 operating profit of $3,530,000 and a net profit of $1,624,000, with gross sales up 61%, $45,683,000 for the year.

The carrier's 1958 results included a net loss of $132,000 on gross revenues of $28,455,000.

Continental's 1959 net profit included $1,200,000 net capital gains from the sale of piston aircraft. Expenses were up 54% to $42,153,000, interest increased from $1,141,000 to $2,361,000, and cash throw-off (depreciation, amortization and profit) was up from $5,111,000 to $10,765,000.

Introduction of Boeing 707-120 service between Chicago, Los Angeles, Denver and Kansas City was cited by the airline as a strong factor in its record revenues and profits. Passengers carried in the jet-augmented Continental fleet totaled 1,107,000 in 1959, an increase of 30%. Revenue passenger-mile total increased 60% to 676,978,000.

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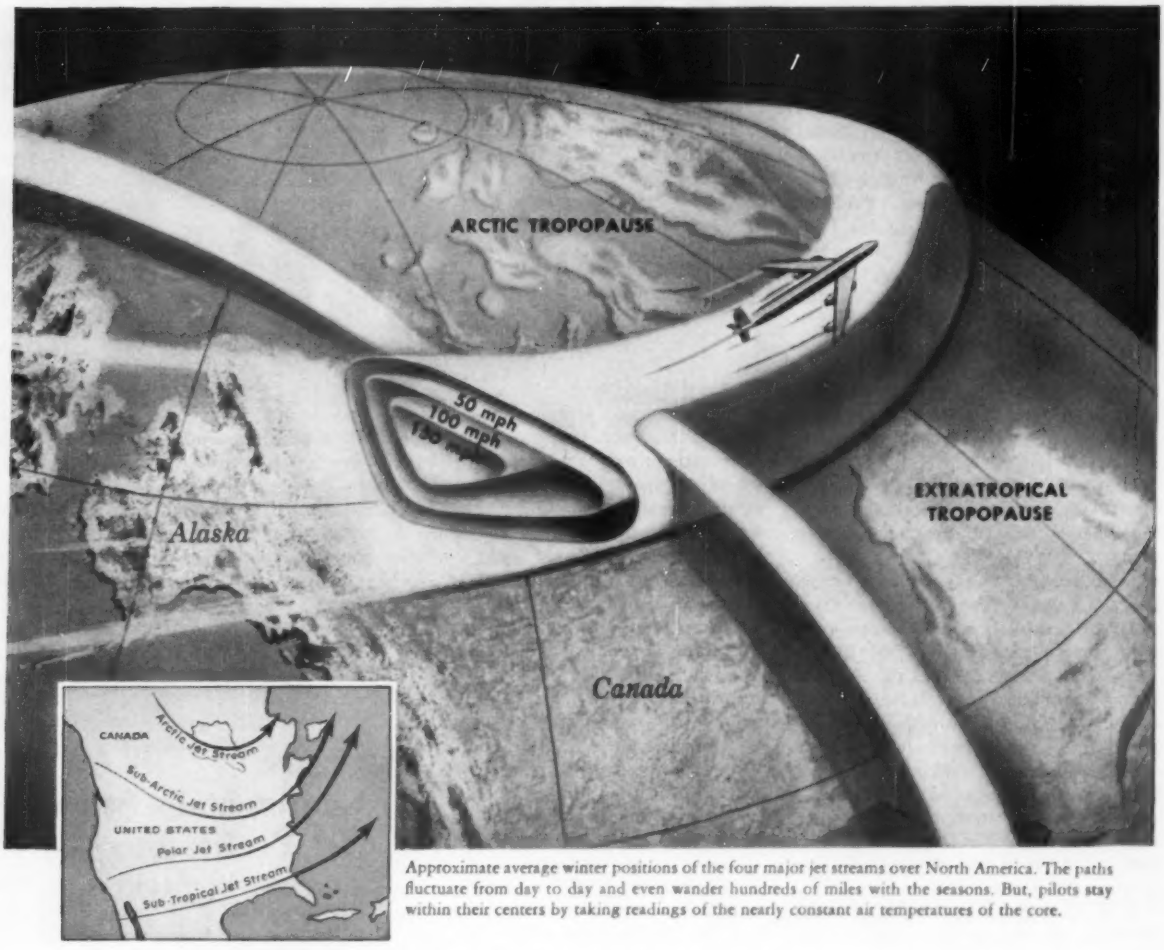

Approximate average winter positions of the four major jet streams over North America. The paths fluctuate from day to day and even wander hundreds of miles with the seasons. But, pilots stay within their centers by taking readings of the nearly constant air temperatures of the core.

TODAY, jets can boost their ground speeds upwards of 150 miles an hour with the help of the jet streams—giant rivers of westerly winds, flowing at hurricane speeds, 2 to 8 miles above the Northern and Southern Hemispheres.

Jet streams are basically a result of the marked temperature variations existing between the tropical, extra-tropical and polar tropopauses, and are usually found coursing along the broad areas where one tropopause overlaps another. Shaped much like a flattened tube, the streams are from 100 to 300 miles in width and from 2 to 5 miles deep. Wind speeds at the core are generally about 150 mph (though much greater velocities have been recorded) and diminish outward from the center.

* * *

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MOBILGAS AIRCRAFT

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Delta Air Lines has taken delivery of the first of 10 Convair 880 turbojet transports. All 10 will be in service this fall. Delta also has six Douglas DC-8s, all in service. Aircraft shown, the first production 880, is expected to be FAA-certificated about May 1.

Delta Is First Airline to Receive Convair 880

Convair 880 can carry 84 first-class passengers or 110 coach passengers at 615 mph. cruise. Range with full first-class payload and normal reserves is 3,450 stat. mi. Takeoff, CAR runway under sea level standard conditions, 1,750-mi. trip, is 5,200 ft.; landing requires 5,300 ft. under same conditions. Four General Electric CJ-805-3s are rated at about 15,000 lb. thrust each.

BEA Chairman Forecasts 'Mass Market'

By Glenn Garrison

New York—British European Airways traffic, boosted by a boom in United Kingdom and European travel, was up 20% in 1959 and is expected to rise another 20% this year, according to BEA Chairman Lord Douglas of Kirtleside.

Lord Douglas told AVIATION WEEK here that the era of mass air travel in Europe "is really coming about" and will be stimulated by new, lower fares scheduled to go into effect this summer. BEA's 1959 net profit was about $5,600,000 after a 5% payment on capital to the British government, Lord Douglas said.

BEA has begun phasing out its last piston-powered aircraft—Douglas DC-3s which handle some short hauls within the U.K.—and by the end of summer will be an all-turbine airline. Its fleet of Vickers Viscount turboprops will be augmented in April by de Havilland Comet 4B jets, which will go first onto BEA's London-Moscow route. First Vickers Vanguard turboprop deliveries are expected in April, with the aircraft scheduled to go into London-Paris service in July.

Short-haul de Havilland DH-121 jet equipment is scheduled for 1963 delivery. Metal is being cut on the first airplane, which will be flying next year, according to Lord Douglas. Finally, BEA is ordering six Fairey Rotodyne VTOLs for 1964 delivery.

In the meantime, BEA is considering purchase of two or three intermediate helicopters. Lord Douglas has flown in the Vertol 107 and Sikorsky S-61 turbine-powered helicopters and said BEA will have to decide within the next two or three months whether to buy one of these rotorcraft, or the Bristol 192, also under consideration. These intermediate helicopters might be suitable for cross-channel operation, the BEA official said, or might be used on BEA's Lands End city routes to serve small airfields.

Twice-Weekly Service

The carrier began London-Moscow service last April and in 1960 has experienced a 58% load factor on the 1,600-mi. route, which is BEA's longest. Viscounts now handle the twice-weekly service, with Russia's Aeroflot operating Tu-104 jet aircraft on a reciprocal basis.

The 57-passenger Viscounts require a stop at Copenhagen, but the Comets will operate nonstop over the route. Aeroflot Tu-104s, which also have stopped at Copenhagen as part of the route agreement, will then operate nonstop. The Russian jets provide 75 seats in mixed first class and tourist configuration; BEA's Comets will be fitted with 24 first class and 68 tourist seats.

Lord Douglas said the BEA-Aeroflot service has been handled under "quite a good administrative arrangement," with a minimum of BEA personnel required at Moscow or Aeroflot personnel at London. The British carrier has assigned only one engineer to the Moscow end.

Technical services are exchanged on a "knock-for-knock basis," Lord Douglas said—i.e., without charge. Each airline maintains a small store of spare parts at the other's home base.

Moscow traffic is growing and will increase in 1960, the BEA chairman said, but the additional capacity provided by the Comet will probably be enough without increasing schedules. American tourists make up most of the Moscow business. According to Lord Douglas, 30,000 Americans visited the Soviet capital last year.

To handle the language problem in the London-Moscow operation, both BEA and Aeroflot carry interpreters on their aircraft. However, the Russians have put English-speaking traffic controllers in their towers at Moscow and at two alternate airports, Riga and Kiev.

BEA's Vanguards in the London-Paris service will carry 25 first class and 75 tourist seats. The turboprops will compete in this market with Sud Caravelle turbojet equipment, but Lord Douglas said the difference in block time on the 225-mi. route will be only about 3 min. and this, the BEA official said, is the most important factor on short-haul routes.

BEA's average route segment is just over 300 mi. Its only route in excess of 1,000 mi. is the London-Moscow run. Generally, Vanguards will handle

FIRST FOUR of 20 Vickers Vanguard turboprop transports ordered by British European Airways (AW May 4, p. 47) are shown at Vickers' Wisley, England, test center where five Vanguards are being used in the current flight test program. First of 20 Vanguards ordered by Trans-Canada Airlines is scheduled to fly this month; seven others have reached final assembly line.

Pan American Gets First Intercontinental DC-8

First intercontinental version of the Douglas DC-8 jet transport, powered by Pratt & Whitney JT4-A (J75) turbojets, was delivered to Pan American World Airways last week. Plane carries 22,000 gal. of fuel, is certificated for a takeoff gross weight of 310,000 lb.

routes up to 500 mi., Comets the longer runs. On a 500-mi. segment like Switzerland-Nice, mixed Comet and Vanguard schedules may be provided.

Lord Douglas favors fare differentials for various types of equipment, but is far from sure that general agreement will be reached on such a move.

The 65-passenger Rotodynes will be operated from the center of London to the center of Paris, and would be suitable for service between London and any large city within a 200 mi. range, Lord Douglas said. But these aircraft will not be competing in the mass market because fares must be higher in them. Fares in the Rotodyne service may be 25% higher than in fixed wing first class service, the BEA official said.

Describing the DH-121 as "a proper short haul jet," Lord Douglas said it should fill a needed gap in the spectrum of equipment, such as the Viscount slipped into in its time. The DH-121 "may well be a winner from that point of view," the BEA official said.

The DH-121, according to Lord Douglas, will carry 75 passengers in mixed service or 100 economy passengers, fly at 600 mph. and operate from 6,000-ft. runways. At the moment, the DH-121 "has got the field to itself," since the American short-haul jet proposals such as the Douglas DC-9 are not moving ahead, he pointed out.

The BEA chairman pointed out the importance of carefully tailoring aircraft to an airline's route pattern and said many airlines lose money by trying to fit planes with too much range or payload onto unsuitable segments. The care BEA has used in approaching this requirement, Lord Douglas said, is illustrated by the 52-page BEA specifications for its Viscounts.

The BEA official said the structure of lower and special fares effective this year in Europe was needed to absorb increased airline capacity and tap a true mass market. Aim of special fares is to induce people to fly at odd times and thereby even out the peaks and valleys of business. To that end, fares are differentiated by time of the year, day of the week, hour of the day.

BEA considers the Air Union combination of four big European carriers as "a very sensible arrangement." Lord Douglas said "people keep talking about Air Union as a threat," but it is not considered such by BEA. He noted that BEA has pool arrangements with almost every airline in Europe, involving scheduling and revenues. The airline has such an agreement with Air France, for example, with several more years to run and renewal is expected.

BEA operates pool agreements with the other members of Air Union, too, and hence "the more prosperous they are, the better it is for us."

A consortium arrangement between BEA and Olympic Airways of Greece begins operation in April. More inclusive than a pool agreement, it will involve joint operation on several Mediterranean routes and others including London-Athens. Each carrier will provide three Comet 4Bs for the services, and some BEA Viscounts and Olympic DC-6Bs also are involved. Major maintenance and overhauls of all the Comets will be done by BEA at London. Crews also may be exchanged for the jet operation, but this is not yet certain.

BEA, although it has no transatlantic route, books a good deal of interline business in the United States. Some $10 million in this business will be booked in the United States this year, according to Lord Douglas.

The BEA chairman does not foresee supersonic transport operation in the 1960s. Being a short-haul airline, BEA would not be a supersonic prospect anyway, but Lord Douglas believes such aircraft generally are "longer away than many optimists think," perhaps 10 or 15 years in the future.

BOAC Management Changes Clarified

London—Shake-ups in the structure of British Overseas Airways Corp., rumored since Minister of Aviation Duncan Sandys started campaigning for greater efficiency in the aircraft industry, now are beginning to take shape.

Ministry of Aviation has confirmed a report that there are changes slated among the airline's top brass control. It announced that Sandys had issued this statement:

"In view of the speculation that has arisen about the membership of the board of BOAC, I should like to make the position clear. Last November, Sir Gerald d'Erlanger told me on account of demands of his private business he would not wish to continue as chairman of BOAC after expiration of his current term of appointment in 1961."

Sandys' added that BOAC Deputy Chairman Sir George Cribbett informed him recently that for reasons of health he would not be able to continue for more than another three months. "I therefore most reluctantly accept this resignation with effect from Apr. 30," he added. Decisions on future appointments are pending.

A BOAC spokesman in London declined comment. Basil Smallpeice, the airline's managing director, is slated for promotion to BOAC's deputy chairman.

Space probe reaches heights of over 500 miles— speeds of over Mach 10— with unprecedented reliability . . .

. . . AND BRISTOL SIDDELEY

One of the largest manufacturers of motive power units in the world, Bristol Siddeley Engines Limited produce the Gamma. A liquid propellent rocket engine, the Gamma powers the Saunders-Roe Black Knight, Britain's highly successful space research vehicle. An extremely reliable powerplant the Gamma produces a total sea-level thrust of 16,400 lb (7,438 kg) and nearly 19,000 lb (8,618 kg) outside the earth's atmosphere, for a total powerplant weight of only 700 lb.

The Gamma has sent Black Knight over 500 miles into space at speeds in excess of Mach 10 with a reliability that is unprecedented. For, to date, the Gamma has never failed to fire successfully.

Since Bristol Siddeley's rocket division began work in 1946, it has developed a wide range of components. By combining these components in single or multi-chamber layouts, thrust requirements from 500 lb up to very high figures can be met.

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Bristol Siddeley Maybach diesel engines power Britain's fastest express train —the British Railways "Bristolian." Two type MD 650 engines, developing a total of 2,200 hp, give the "Bristolian" a top speed of over 90 mph.

The Bristol Siddeley Orpheus, the world's most advanced lightweight turbojet engine, powers this Fiat G 91, NATO standard lightweight strike fighter. The Orpheus is in service in six different aircraft and is specified for eight others.

The Bristol Siddeley Proteus powers the Britannia airliner. Four Proteus give this 130-seat aeroplane a speed of over 400 mph—a range of over 5,000 miles. Britannias are in service with twelve airlines and with RAF Transport Command.

AIRLINE OBSERVER

► Domestic trunkline prices on the New York Stock Exchange continue to follow a steadily dropping market. With rare exceptions, most trunkline common stocks held close to 1960 lows throughout the earlier part of last week, and several companies hit new lows for the year.

► CSA, Czechoslovakian airline, is scheduled to replace its Il-14 transport aircraft with Tu-104 turbojet transports on its Prague-London route beginning Apr. 1.

► International Air Transport Assn. resolution establishing a new fare structure in the Western Hemisphere has been tentatively approved by the Civil Aeronautics Board. Specifically, the resolution adopted by traffic conferences last year in Honolulu (AW Oct. 19, p. 38) calls for these changes: increases ranging from 3 to 8% in first-class fares, introduction of northbound directional fares at 20% under normal tourist fares and adoption of jet surcharges ranging from $2 to $28. Tourist fares remain the same. Northbound directional fares from Chile will reflect reductions of 20 to 25%.

► Some British engine experts fear Britain is two years behind the U. S. in turbofan engine development and that this will greatly compound Britain's competitive problems in selling jet transports in world markets. They feel the British industry should abandon the long-range jet category and concentrate on competing with the U. S. with a short or medium-range turbofan project. Observers feel one factor behind the turbofan lag is Britain's use of engines buried in the wing, making installation of larger diameter turbofan engines a problem in current aircraft.

► Port of New York Authority has partially automated its monitoring of jet takeoff noise at New York International Airport. An automatic system has been mounted on a pole approximately one mile off the end of a major runway. When noise reaches a certain decibel level, the automatic unit is tripped, and the reading is sent by wire to a special operations unit in the airport terminal. Other runways are still monitored by personnel in automobiles, but the automatic system may be extended later.

► Federal Aviation Agency has amended Civil Air Regulations to require one pilot at the controls of an aircraft flying above 35,000 ft. to wear an oxygen mask at all times. All other flight crew members are required to wear oxygen masks that meet fast-donning requirements.

► Aerovias Ecuatorianas may lose its U. S. foreign air carrier permit to operate between Ecuador and Miami via Panama. Civil Aeronautics Board has asked the carrier to show cause why the permit should not be canceled on grounds that the Ecuadorian government has canceled the airline's authority to operate the route because it has failed to serve it for the past several years.

► Civil Aeronautics Board members Alan S. Boyd and Whitney Gillilland have dissented against a majority opinion granting Flying Tiger Line an exemption that extends to June 30 on an agreement with Lufthansa to provide two round trip flights weekly for the West German flag carrier between Frankfurt and New York. In granting the exemption, the majority noted that the State Department urged its approval as being "in the national interest." In his dissent, Boyd said he did not believe that traffic should be diverted from U. S. carriers over an extended period of time "by a foreign carrier through the facilities of a U. S. carrier not certificated to serve the line under review." He suggested two years as a maximum period for such leases.

► Vickers-Armstrongs is proposing a freighter version of the VC. 10 cargo transport with a swing-nose. Vickers feels it has overcome difficult control and systems breakage at the front to gain significant weight advantages. This is because a joint in the nose does not have to stand the same order of aerodynamic loads that a swing-tail layout would, the company said.

SHORTLINES

► **British Overseas Airways Corp.** will resume service to Cairo within the near future after a four year suspension of operations following the 1956 Suez crisis. The airline has settled all points of negotiation with the United Arab Republic government. Ground handling operations will be conducted by Karnak, the Egyptian travel organization.

► **Air Maroc of Morocco** has picked up its option on a second Sud Aviation Caravelle. The French aircraft manufacturer has now received orders for 61 of the turbojet airliners.

► **Lockheed Air Service** has signed an agreement with Bristol Aero Industries, Ltd., of Canada for inspection and maintenance services on the Proteus 760 turboprop engine used on the Bristol Britannia turboprop transport at Lockheed's New York International Airport overhaul base. Service will be available to airlines with Britannia service into New York.

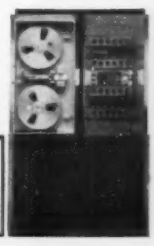
► **Military Air Transport Service** has invited 96 civil air carriers to quote bids for transporting outsize cargo during Fiscal 1961. Bidders must be able to furnish aircraft with specific types of loading facilities and doors capable of receiving large, extremely heavy cargo. Bids must be received at Scott AFB, Ill., no later than 4 p.m. on Mar. 18.

► **Napier Engines, Inc., of Canada** has appointed William C. Wold Associates of New York as U. S. & Central American sales agent for the Convair 540 turboprop aircraft in the corporate and executive transport field. B. J. Vierling and Aircraft Supply Co. of Washington will continue to specialize in the airline aircraft market. The airliner, powered by Napier's Eland turboprop engine, has been in operation with Allegheny Airlines since July, and the carrier has ordered five more of the aircraft, with options for an additional 15.

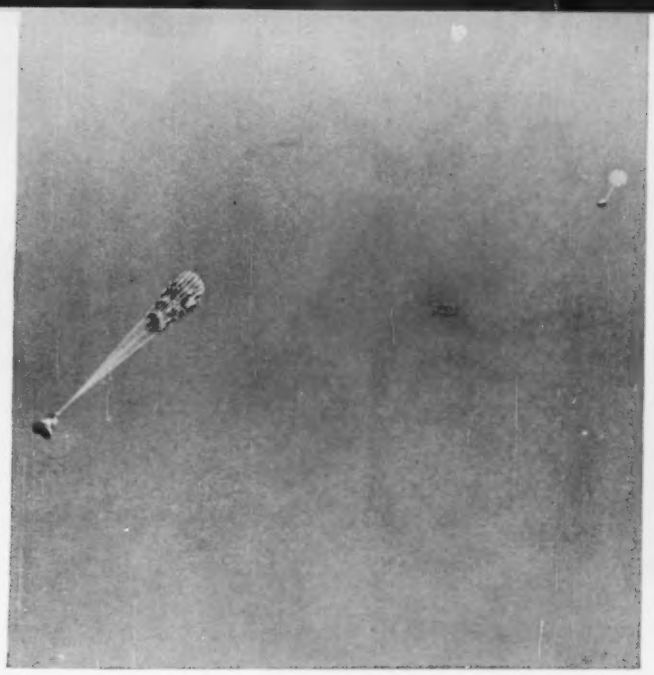
► **Pan American World Airlines** is replacing all piston aircraft on its Middle Eastern routes with turbojet aircraft and expects to complete the operation by the end of this month. The airline has received authorization from the Civil Aeronautics Board to suspend service to Mezze Airport at Damascus because the airport's runways are inadequate for operation of large turbojet aircraft. The United Arab Republic has advised Pan American, however, that a new and larger airport will be constructed at Damascus and that it will be in operation by 1962.

All magnetic tape recorders consume magnetic tape. Most have a prodigious appetite. It is because they have to run very fast to capture a broad frequency range. Running tape fast is the easy way to get wide bandwidth. But you pay for that bandwidth again and again with every data run in every month of every year you use the machine. You pay in high tape consumption and high tape costs. The Ampex FR-600 achieves the same bandwidths at half the tape speed you now need. At half the tape cost therefore. At 60 ips the FR-600 has a 250 kc bandwidth. At 30 it has 125 kc and so on. No matter what the bandwidth you can now record it at half the speed, on half the tape, at half the cost on an FR-600. The savings in just a short time can be astonishing. If you use 30 14-inch reels of 1-inch, 1-mil tape each week your weekly tape bill is $5100—minimum. An FR-600 can save half of that each week and literally buy itself in 15 weeks. In your particular case it might take more time —or less—but it's a fascinating reason for getting the full FR-600 story. AMPEX DATA PRODUCTS CO., 934 Charter St., Redwood City, Calif.

This instrumentation recorder can buy itself in 15 weeks

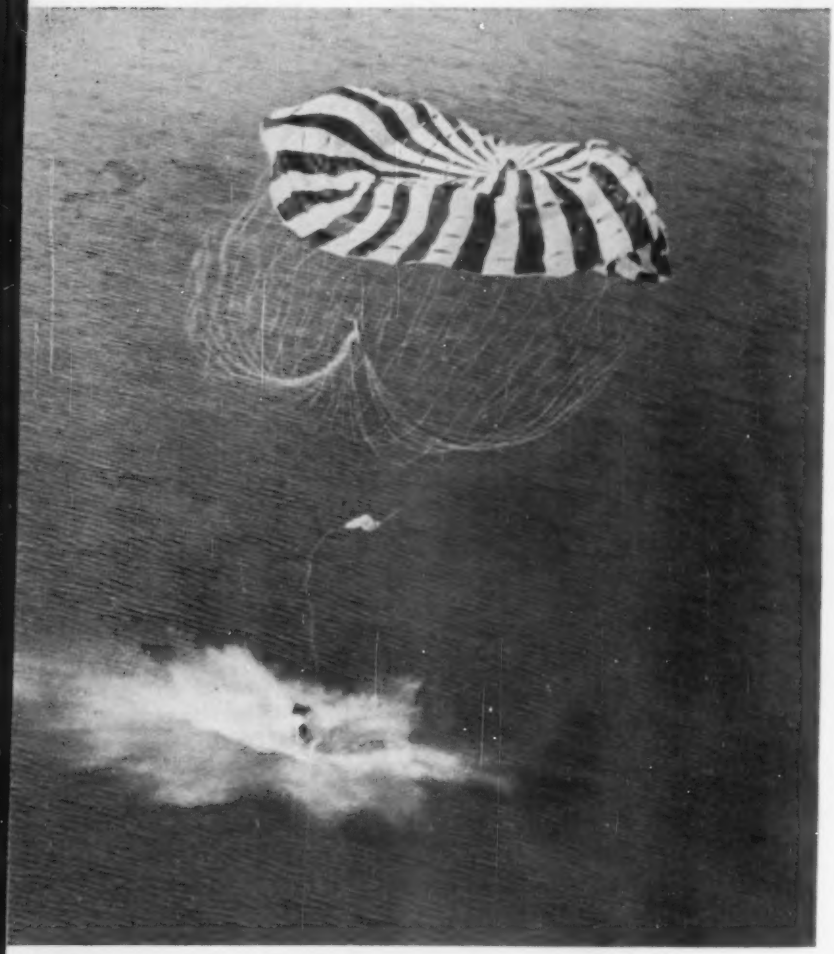


FR 600 AMPEX



Full-size model of the Project Mercury man-in-space capsule was used in the 35th successful drop to check the reserve parachute letdown system. Drogue chute separates (left), carrying capsule's antenna fairing and the sled used for installation in a USAF Lockheed C-130 transport which made the drop from 31,100 ft. over the Salton Sea, Westmorland, Calif. Closeup of capsule sled is at right.

Radioplane Tests Mercury Capsule Landing System



Test capsule weighs one ton and is landed by a Ringsail parachute developed by Northrop Corp.'s Radioplane Division. Drop rate is 30 ft./sec. A failure condition in the landing system was deliberately built in to test the reserve chute (shown at impact, left). Chute, which is the same size as the main chute, disconnects automatically at impact.

Mercury Pilot's Orbital Role Described

San Antonio, Tex.—Important role the Project Mercury astronauts will play in successful orbital missions, despite the high degree of automation being built into these vehicles, was described at USAF's Aerospace Medical Center, Brooks AFB, during a space medicine lecture by Lt. Col. William K. Douglas, the astronauts' flight surgeon.

Dressed in his fully pressurized suit, the selected astronaut will be taken out to the pad, placed in the capsule and tightly strapped into his form-fitting, custom-made couch. This will occur approximately 2 hr. prior to launch time. Actual preparation for the flight starts at least three days before the launch, Lt. Col. Stanley White, aeromedical consulting staff, Langley Research Center, Va., noted. Gastro-intestinal preparation, including a special low-residue diet designed to lessen handling of fecal wastes, will be included. During the last day he will be isolated from all outsiders. Launch schedule will be planned watching solar flare activity to avoid a high-activity period.

Capsule Checkout

After the astronaut is securely strapped in, the lid to the entrance hatch of the McDonnell capsule will be secured with 140 nuts, bolts and screws. Capsule checkout procedure takes approximately 30 min., so for approximately one hour the astronaut will sit secured in the capsule waiting for T minus zero, or a sudden emergency abort signal, which will send him, three seconds later, 2,500 ft. into the air with an acceleration lasting slightly over one second and peaking at approximately 20g.

If all goes well, the Atlas intercontinental ballistic missile carrier will accelerate to a peak of 8g in a little over 2 min., then staging occurs, the two booster motors fall off, and acceleration will drop abruptly to 1g but builds up to 9g by the time the sustainer motor burns out. The capsule and its contents are then abruptly weightless. Weightless period for the Mercury capsule and the astronaut will vary in the course of the flights programed—early flights will make up to three orbits each lasting approximately 1.5 hr., some 100 naut. mi. above the earth. Schedules encompassing 19-orbit flights with Mercury-type vehicles are in the planning stage for the next few years, AVIATION WEEK learned.

As soon as separation from the sustainer occurs, the autopilot stabilizes the capsule in about 5 sec., rotates it 180 deg. in the yaw axis and also 35 deg. base up in the pitch axis, so that the capsule is positioned in the retrofire mode. This is to assure that retrofiring can occur at the soonest possible moment to avoid landing on the continent of Africa if full orbital velocity or programed orbit parameters have not been obtained.

Up to this time, if all goes well, the astronaut has taken no active part in the flight, Col. Douglas noted, though during this phase he has a critical passive role. For his own safety he must monitor instruments and indicator lights which will clue him on proper functioning, or malfunctioning. His left hand will always be on the abort handle and he is capable of firing the escape rockets anytime after the Atlas carrier has ascended 2 in. off the launch platform. This inability to abort prior to liftoff is a pad-safety feature, but it does introduce an element of uncertainty and dependency into the pilot's mind, Douglas explained.

From liftoff to entry into the orbit, he must remain alert and prepared to manually operate a number of vital items which normally would be taken care of by the automatic system, including activation of the cabin oxygen purge bottles—to fill the cabin with 100% oxygen, jettison the escape tower 15 sec. after staging, and separate capsule from the sustainer, if these events are not done automatically.

Mercury capsule is an attempt to develop an optimum sealed capsule, with specification requiring no more than 500 cc./min. leakage, dependent on a new technique of manufacturing that still awaits final demonstration, Col. White pointed out. The abundance of oxygen aboard provided in the environmental system allows a redundancy for greater amounts of leakage, especially on early short flights. The astronaut will wear a suit that provides automatic backup for the cabin system in the event of capsule rupture or should oxygen utilization get beyond tolerable limits, he added.

At insertion into orbit, the pilot must be prepared to manually orient the capsule for retrofiring if the automatic stabilization system does not function, and after the stabilization in orbit he must then maneuver the capsule in various axes for purposeful observations of the earth and sky, Col. Douglas noted. A single handle on the pilot's right side provides control over all three axes, configured into the center of rotation of the three major motions around the wrist joint. Pitch is controlled by radial and ulnar deviation of the wrist, yaw by flexion and extension of the wrist and roll by supination and proneness.

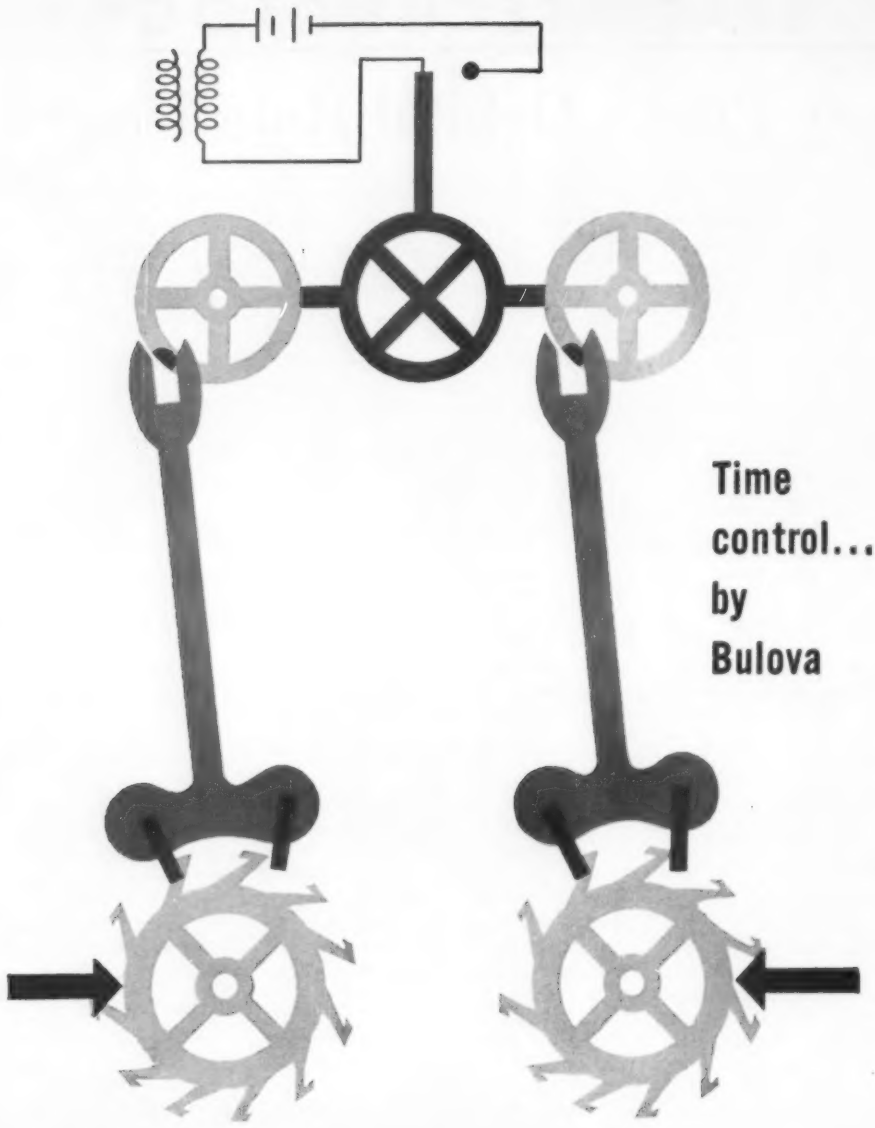
To further complicate matters, there is no aerodynamic damping in the vacuum of space, so once the capsule is started into motion by a control movement, it will continue that movement and at the same rate until an equal and opposite control force is applied—reaction control for the Mercury capsule being supplied by hydrogen-peroxide jets, with maximum throw of the control providing up to 25 lb. thrust.

In positioning the capsule, the pilot will not rely on coordinated movements. Instead, he will rotate the capsule in the yaw axis, then in the pitch axis. Coordinated movements are not possible, Col. Douglas added, because of control cross coupling and gyros with only 2 deg. of freedom. Reference items provided the pilot are a conventional three-axes artificial horizon modified to give all three indications on one instrument to reduce need for scanning, a window so that he can see the horizon and a periscope so that he can view the horizon.

Earth View

The earth-viewing periscope gives a field of view of the earth with a "magnification" of 0.7, presenting a 19-deg. view of the earth's surface in the inner 5 in. of the unit's field. Outside this 5 in. circle is presented a view of the earth from horizon to horizon—the viewing angle of the scope being slightly more than 180 deg. With this periscope and strip maps, time clocks, and other navaids, the pilot will be required to perform certain navigational problems presented to him before departure, such as determining time over various easily recognizable geographical landmarks. The periscope will be used as an orienting and stabilizing instrument in event of failure of more elaborate equipment.

In orbit, the pilot also handles other active tasks, such as making periodic reports to ground tracking stations and relaying vital instrument readings to confirm data telemetered to the ground. He also will monitor cabin pressure, oxygen tank pressure and CO_2 since he may be the first to detect that these are reaching dangerous values and he is the



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only one who can take corrective action.

There is no automatic faceplate on his helmet, and if rapid decompression should occur or, even more dangerously, slow decompression, the pilot must get the faceplate closed and evaluate the situation to determine further action, which may include voluntary immediate initiation of the retrofire sequence for return from orbit. It is hoped, Col. Douglas said, that the pilot will be astute enough and calm enough to avoid re-entry at a point that would result in landing in other than primary or secondary recovery areas. If the emergency dictates otherwise, he must then be prepared to survive on land or water any place between 40 deg. north latitude and 40 deg. south latitude.

Scientific observations also will be required, such as reconnaissance of cloud cover, auroral displays, astronomical observations, body sensations, presence or absence of illusory phenomena and any variations from normal earthbound subjective sensations.

Shortly after completion of the third orbit, the capsule will be prepared for re-entry. Re-orientation of the capsule will be performed automatically, but the pilot must be prepared to take over in event of failures. The capsule must be oriented with its broad base forward and elevated at 35 deg. prior to reaching the predetermined point where the retrorockets are to be fired. If the capsule is out of alignment beyond specified limits, a locking device prohibits firing the retrorockets. There are three of these rockets aligned so that their center of thrust is through the capsule's center of gravity. Each rocket fires for 10 sec., but each is fired 5 sec. after its predecessor in a "ripple" pattern.

Exact center of gravity of the capsule cannot be predetermined since it is subject to change and depends on factors such as fuel consumption, oxygen consumption and the like, imposing another guidance task on the astronaut. After retrofiring, the capsule is oriented into the re-entry attitude, which is a base-down angle of 1.5 deg. As the atmosphere is entered, aerodynamic forces build up to cause oscillations, these being of such magnitude that capsule attitude cannot be accurately maintained by the reaction control jets.

However, it still will be necessary to apply counteracting control forces to prevent the oscillation rate from building beyond unacceptable limits. At approximately 10,000 ft., a ribbon parachute is deployed to lower the capsule to the surface with an impact velocity of 30 fps. This is another instance where the pilot will have to monitor the automatic system and be prepared to manually activate the parachute, then determine the status of the primary parachute; if unsatisfactory, jettison and deploy the secondary canopy.

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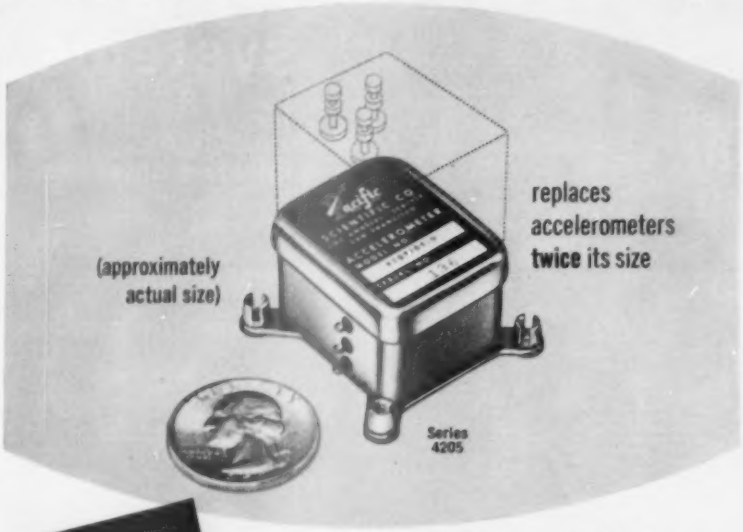

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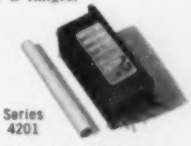
Series 4201

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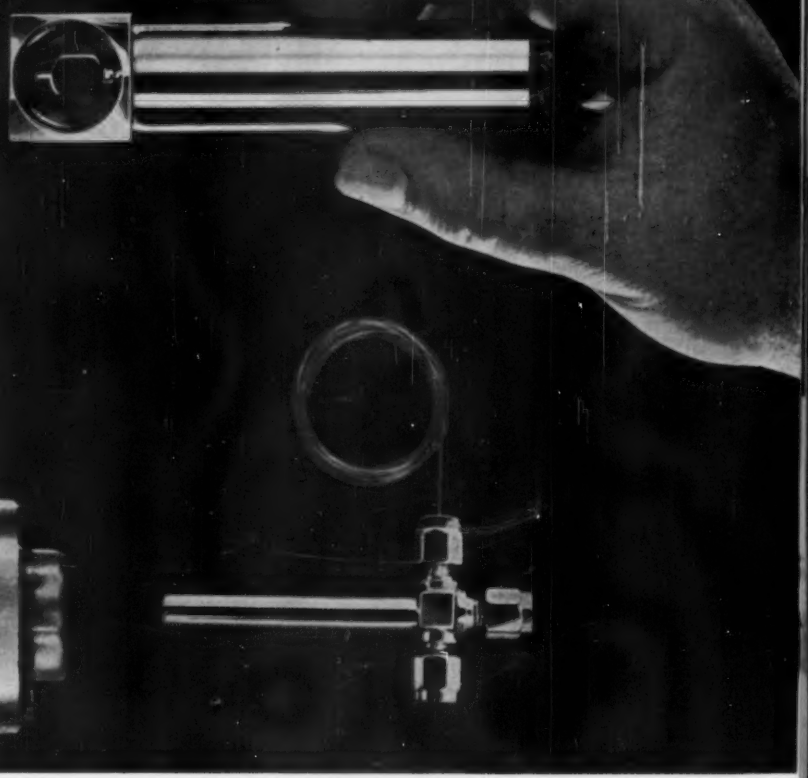

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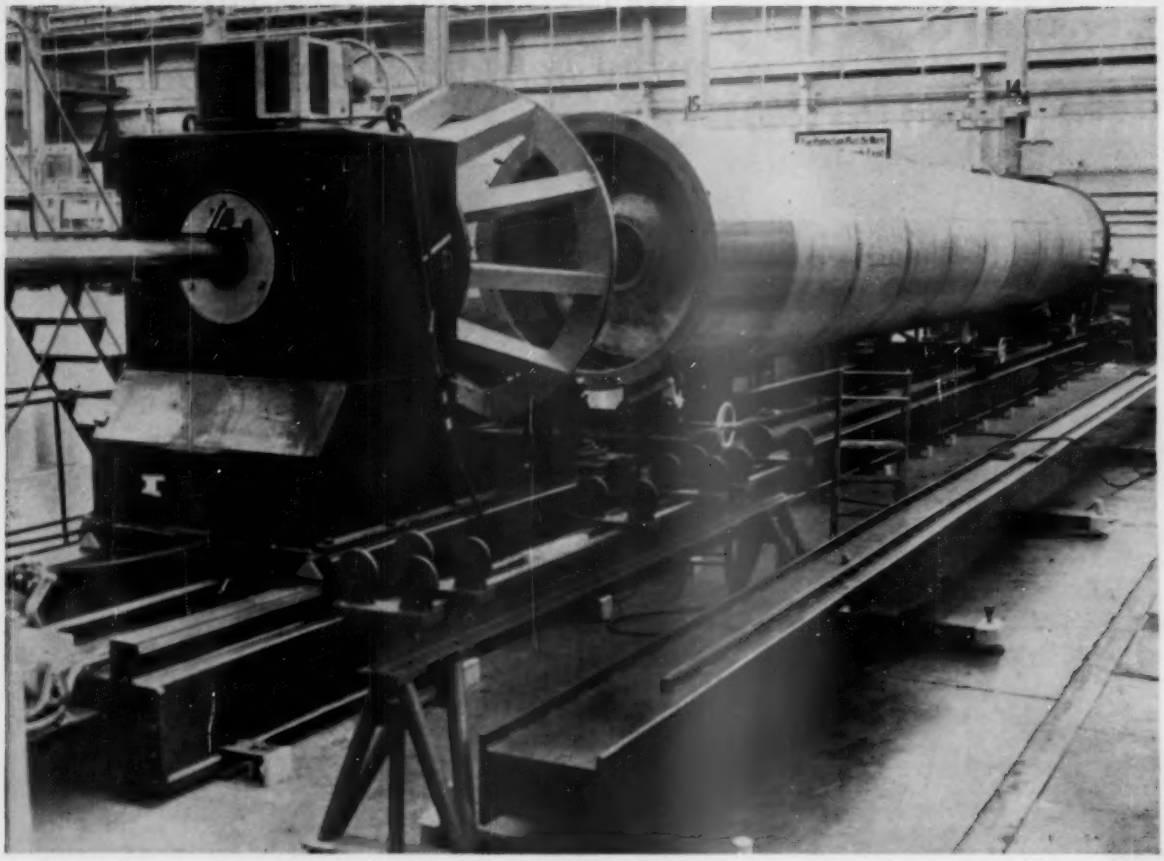
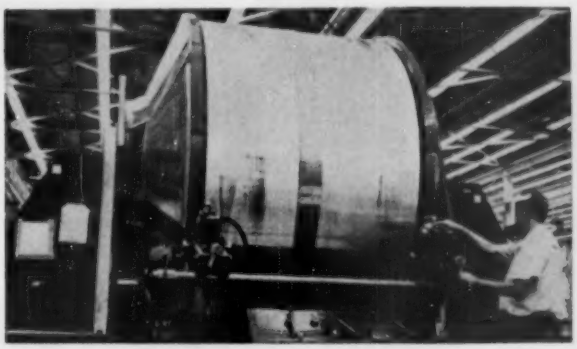


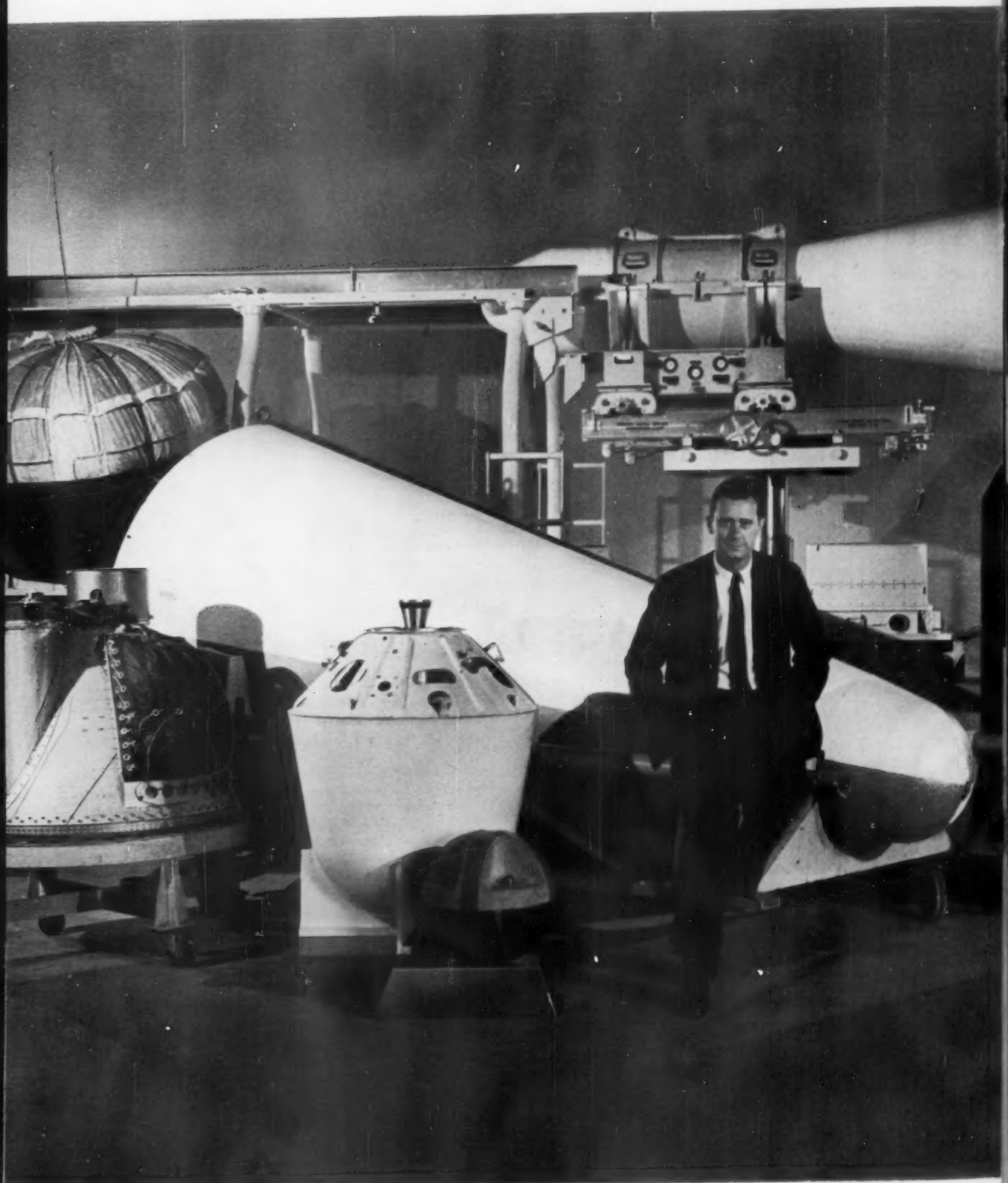
One of eight 70-in.-diameter tanks which will contain fuel and liquid oxygen for the Saturn space vehicle booster is shown in a metal-working machine at Army Ballistic Missile Agency's Redstone Arsenal at Huntsville, Ala. Saturn will be 22-ft.-diameter when completed.

Saturn Vehicle Tankage Takes Shape at Huntsville

Tankage for the Saturn 1.5 million-lb.-thrust space vehicle booster is taking shape rapidly at Army Ballistic Missile Agency's Redstone Arsenal at Huntsville. The tanks will feed eight Rocketdyne H-1 liquid fuel engines grouped in a cluster and each developing 188,000-lb. thrust. Much of the fuel will be carried in a Jupiter intermediate range ballistic missile sheathed in Alcoa aluminum; eight modified Redstone missile tanks containing fuel and liquid oxygen will encircle the Jupiter. The aluminum is Alcoa alloy 5456, considered highly weldable. About 11 tons of 5456 are needed for the tanks. Forgings also are of this alloy. Five spun bulkheads (below, left) are used in forming oxygen and fuel compartments in the 70-in. diameter tanks which, in turn, are clustered around the 105-in. diameter tanks. Alcoa aluminum sheet is formed into the 105-in. segment (below, left). Placed in a metal-working fixture, the sheet is trimmed to ensure precise alignment when the cylindrical sections are joined. When completed, the center tank will be 60 ft. long. The engine cluster will be fired later this year on a static test stand which has been specially modified for the Saturn project (AW Feb. 8, p. 29); even though modified for the extremely high thrust, one side of the tower can still be used for static testing of Jupiter IRBMs. Huntsville engineers have completed a million gallon capacity steel water reservoir which pumps 40,000 gpm. to the blast deflector to quench flames and heat from the tests.



4000 subcontractors are represented re-entry vehicle "family portrait"



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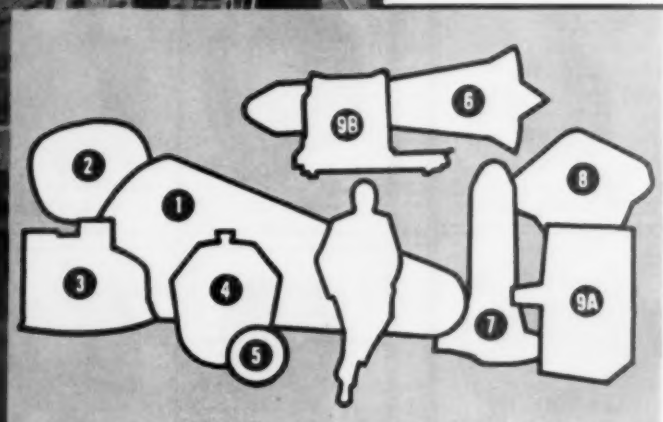
4 years of USAF, G.E., SUBCONTRACTOR re-entry vehicle progress

The key to this progress has been teamwork . . . teamwork between General Electric's Missile and Space Vehicle Department, the Ballistic Missile Division and the Ballistic Missile Center of the United States Air Force and the over 4000 small and large subcontractors alike who have helped MSVD make so many vital contributions to U.S. re-entry vehicle progress.

IN 1959 ALONE, the following figures indicate the emphasis MSVD placed upon this important factor of subcontractor teamwork on Air Force projects.

- Over 35,000 different purchase orders were placed by MSVD on subcontractors in 1959.
- More than 25,000 of these MSVD purchases were made from "small" subcontractor businesses.
- More than $26,000,000 worth of goods and services were purchased by these 35,000 orders. This amount represented a major portion of the contract dollars received by MSVD.
- And more than $13,000,000 of this $26,000,000 went to "small" business firms.

If you'd like more information about G.E.'s Missile and Space Vehicle Department . . . its subcontracting activities, its re-entry vehicle programs or about any of its space technology activities . . . write to Section 160-70, G.E. Missile and Space Vehicle Department, 3198 Chestnut Street, Philadelphia 4, Pa.



Mr. Hilliard W. Paige, General Manager, Missile and Space Vehicle Department with Air Force re-entry vehicles developed by MSVD.

1. RVX-2 Re-entry/Recovery Vehicle, the largest ablation-type re-entry vehicle to travel full ICBM-range and be recovered.
2. Flotation balloon used in recovering USAF-MSVD research re-entry vehicles.
3. Recovery equipment package for RVX-2.
4. Satellite Aeromedical Re-entry/Recovery Vehicle for USAF Discoverer Program.
5. Mark-2 recoverable Data Capsule which flew in Thor re-entry vehicle and returned first films from outer space.
6. Mark-3, an advanced operational-type re-entry vehicle for Atlas.
7. RVX-1, first ablation-type re-entry vehicle to be recovered after full ICBM-range flight.
8. Mark-2, first U.S. operational heat-sink re-entry vehicle now in use on USAF Thor and Atlas missiles.
9. Typical ground support equipment developed by MSVD for USAF use. (A) Mark-2 prelaunch check-out console. (B) Mark-3 missile mating equipment.

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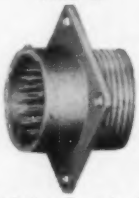

3-Point Cam Lock Back Panel Mounting

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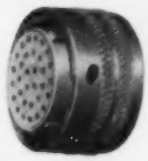
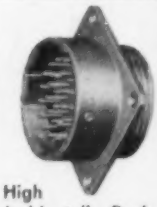


Straight Plug

Jam Nut Receptacle

Thru-Bulkhead Receptacle

Solder Mount Receptacle



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JPL Studies Future Solar Power Units

By Richard Sweeney

Pasadena, Calif.—Advanced techniques for electrical power demands of lunar and deep space probes are being developed and evaluated at National Aeronautics and Space Administration's Jet Propulsion Laboratory here.

Power supply development, judged one of the knottiest space technology problems, is being pushed at JPL to meet three general future periods:

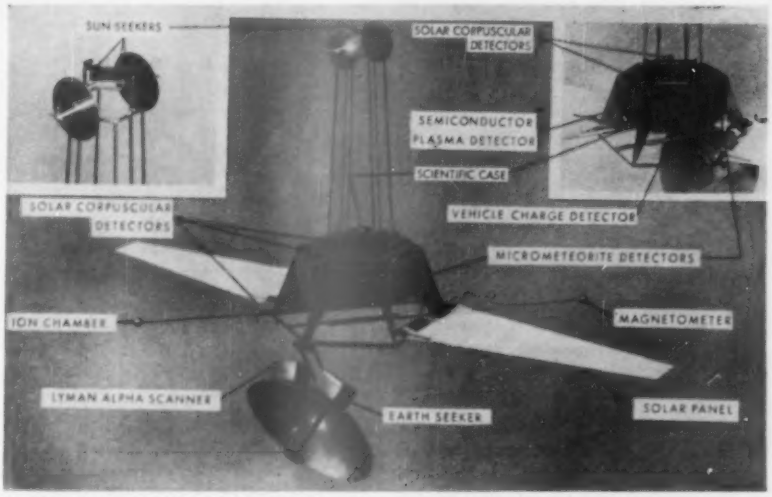
- **One to three years.** Solar cells will predominate as the power source in this time span, JPL feels.
- **Three to five years,** during which solar furnaces will produce high temperatures for translation into electrical power through thermionic devices or to heat a working fluid which will drive another type generator.
- **Six to 10 years,** when lightweight nuclear reactors should be usable to create heat for similar subsequent conversion to power.

Engineers at JPL indicate today's power supply state-of-the-art makes possible ratios ranging from 0.2 or 0.25 w. to one watt per pound of payload under optimum conditions. Present JPL payload projections call for 500 lb., plus or minus 200 lb. for lunar unmanned instrumentation payloads, and 300 lb. for deep space probes which include a guidance system functioning after thrust termination. JPL feels that a ratio of one watt per pound of payload should serve for unmanned instrumentation payloads for the next 10 years.

Economic Aspects

Studies of various power-generating techniques at JPL include analyses showing these economic aspects:

- **Using solar cells,** price of each regulated watt delivered to the using component is from $500 to $700, perhaps $1,000 under certain conditions. This is for hardware alone, with no development cost included.



PROPOSAL by Jet Propulsion Laboratory for a space payload configuration uses two solar panels as a power source. Panels indicate payload would go to moon, Venus or orbit earth.

- **Radioisotopes can deliver** power at $3,000 to $5,000 per regulated watt at the using component.
- **Nuclear reactor costs** are not settled. There are several available approaches, each with unsolved problems which could affect cost.

Since the use of rotating machinery to regulate power would compromise reliability in comparison with the use of solid state techniques, JPL feels the latter should be used on space vehicles where flight time exceeds 100 hr.

However, solid state avionics operation in space environments has brought new problems, such as changes in component capability due to lack of air, compared with standard capability ratings now in use which were calculated for operation in an air-and-gravity environment. This requires a comprehensive nationwide re-rating program for avionic components to be operated in space systems, JPL feels.

Analysis indicated that greatest return for investment would be to use power sources to meet electrical requirements, rather than energy sources. Power sources are solar and nuclear, with output measured in watts. Energy sources include batteries, fuel cells, and chemical conversion systems, with output measured in watt-hours.

Weight Increase

A plot of weight against time for auxiliary power supplies, JPL says, shows energy sources weight increasing with a slope of almost 45 deg., while the power source curve shows constant weight with time increase.

- **Power source** is better than an energy source.
- **Morphological (three-sided)** chart is made of power requirements, methods of satisfying them and necessary lifetime.
- **System selection parameters** are studied for reliability, efficiency, cost per watt and regulation.
- **Power supply development** and use is geared to payload weight and time requirements, using the ratios mentioned earlier, with but comparatively small variations.

Current state of the art has solar cells operating at 8% efficiency in converting the sun's heat to electrical power above earth's atmosphere. The sun produces, in space near the earth, 140 w. of heat per sq.cm., leaving 92% to be radiated. Solar cell panel effectiveness is a function of the cosine of the angle of incident sunlight, dictating proper panel orientation to obtain maximum efficiency.

Mission of JPL is development of lunar exploration and deep space probe payloads. Experiments composing the payloads developed for the now-can-

Methods of Providing Space Power

Required: A 100 w. power level for 150 days for an unmanned Mars space probe.

A. Energy Storage Systems:	
Batteries— giving 100 watt-hours per pound	3,600 lb.
Fuel Cells—giving 250 watt-hours per pound	1,420 lb.
B. Power Conversion Systems:	
Oriented solar collector-thermionic diode (collector weight—0.2 lb./sq. ft. and 2.5 watts per diode)	47 lb.
Radioisotope-thermionic diode converter (isotopes yielding 2.85 watts per pound and 2.5 watts per diode)	35 lb.
An oriented solar cell panel on Mars (5 watts per pound)	20 lb.

Solar Power System Parameters

Power System Performance	A	B	C	D	E	F
1. Standard panel area—ft.[2]	10	10	10	10	10	10
2. Number of panels each flight	2	2	2	2	2	6
3. Unregulated output per panel—W.	70	70	70	70	110[1]	43[1]
4. Total unregulated solar panel output—W.	140	140	140	140	220	258
5. Power system output required[2]—W.	102	102	102	102	158	158
6. Power system output available—W.	95	95	95	95	149	175
7. Power system output margin—W.	−7	−7	−7	−7	−9	+17

[1] Higher effectiveness solar cells.
[2] Dec. 14, '59 survey.
A, B, C, D systems would either orbit the earth or go to the moon.
E is a Venus payload, F is for Mars.

celled Vega project generally are expected to be flown on the Atlas-Agena (AW Feb. 8, p. 73), with substantially the same missions.

JPL selected 250 w. as the nominal auxiliary power level for the Vega payloads. Solar cells furnish this power. For lunar and Venus missions, two solar panels are used, each having 10 sq.ft. of cell area, while for Mars, six of the 10 sq. ft. cell area panels are used. The difference is because the first missions are toward sun, the other away from it.

Trapezoidal honeycomb panels on which cells are mounted are fabricated from aluminum alloy sheets and foil core. The core has a pinhole in each cell which allows air to escape during vehicle's climb through atmosphere so that all air is gone when the thrust period is over and the payload is in free flight in space. Escaping air (or any gas) would generate a disturbing torque on payload attitude orientation, increasing the work of the attitude control system which keeps solar panels oriented.

Shingle Effect

Individual solar cells have a 2 sq. cm. rectangular area. They are soldered into groups of five, with the long edge of each slightly overlapping on the next to give a shingle effect. Shingles of five, costing $25, yield 10 sq. cm. of solar heat converting area each, and are connected in series on the Vega panels. Shingles are bonded to panel surface with electrically insulating, but thermally conductive adhesive, since 92% of solar heat must be conducted through the panel and radiated on the dark side surface. Panels cost $35,000 each for hardware alone—no development costs are included—but solar cells still are the cheapest long-term power source available for Vega payload time-era use.

While 1 kw. now is considered the maximum power level achievable with solar cells, JPL feels that with technical ingenuity and aggressive structural techniques research, this can rise to at least 10 kw. Solar cell efficiency is expected to rise to 10.5% within 1½ years. Using the unrolling "window shade" technique, the required increase in solar cell area could be added in increments as required by increasing distance from the sun on a vehicle traveling to Mars, Jupiter or Saturn.

JPL expected attitude control system for Vega payloads would be able to allow deviations of from five to 10 deg. before a significant power loss occurred, according to calculations under the cosine law, making requirements much less stringent for the time periods involved in Mars and Venus flights than if a one or two degree attitude orientation had to be maintained. Rechargeable nickel cadmium batteries are part of the payload power supply to provide for dark side flight time.

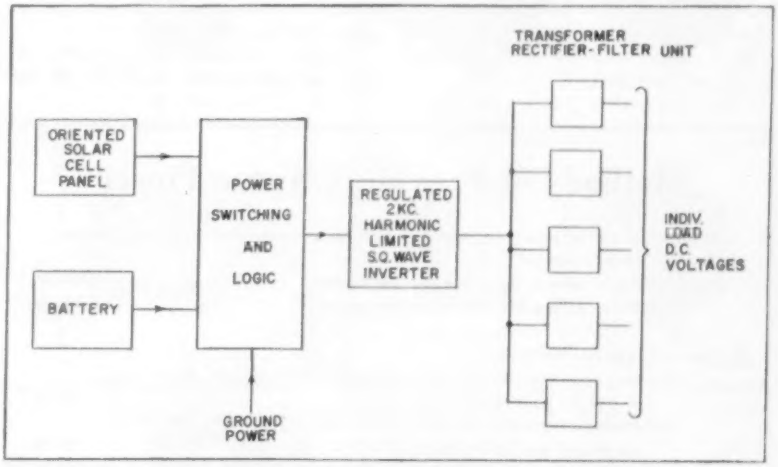
JPL considered a radio-isotope power source for Vega payloads but discarded the system because of cost and difficulty of preventing personnel contamination in case of mishaps. Isotopes radiate constantly throughout their half life and are not controllable like a reactor. JPL feels that government approval will be given to fly reactor nuclear power sources before radioisotopes are allowed.

However, radioisotopes look attractive for lunar-impact payload power sources if impact survival can be guaranteed. Power source would have to operate through an entire one-month lunar cycle for adequate measurement of all phenomena. Isotopes also would do well as power source, JPL feels, for a lunar surface crawler vehicle required to make scientific measurements for 200 to 300 hr. and return data to earth. Solar cells might be used, but danger of breakage at impact, coupled with the difficulty of erection and orientation after landing make the scheme unattractive. Also, a storage system would have to be provided for dark-side operation.

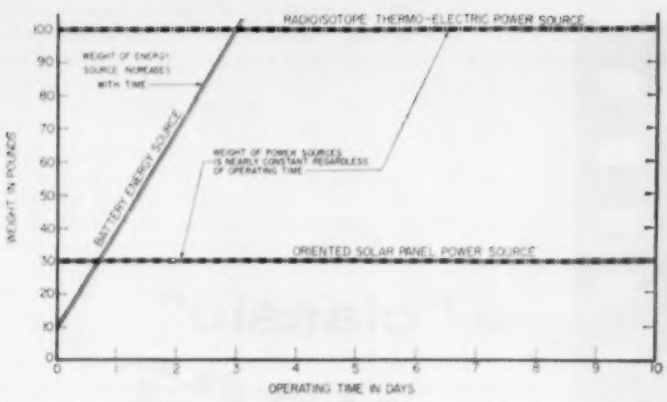
Nuclear Power

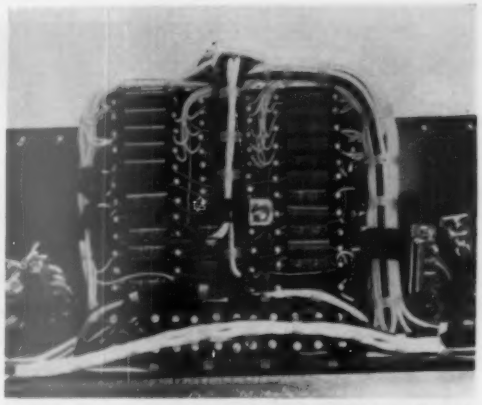
JPL scientists say that if a nuclear power system were utilized in a lunar impacting payload, much more data would be gathered and returned to earth or data quality would be much higher, compared with batteries or chemical conversion systems such as fuel cells. Also, power available with a nuclear system would permit use of a beacon on an impacted payload, on which subsequent payloads could home and impact in the same area, they point out.

Communications and power supply are closely related on unmanned, data-gathering payloads. JPL feels communications is the least efficient user of power. Power supply for communications had been generally established for the Vega lunar vehicle at 100 w.



SCHEMATIC of circuitry for a typical power supply is detailed above. The system has provision for rechargeable batteries in addition to solar panels.


RADIOISOTOPE THERMO-ELECTRIC POWER SOURCE
WEIGHT OF ENERGY SOURCE INCREASES WITH TIME
BATTERY ENERGY SOURCE
WEIGHT OF POWER SOURCES IS NEARLY CONSTANT REGARDLESS OF OPERATING TIME
ORIENTED SOLAR PANEL POWER SOURCE
WEIGHT IN POUNDS
OPERATING TIME IN DAYS



COMPARATIVE weights as envisioned by JPL Space Power Group technicians reflect various stages of development (left), and optimism. Additional elements—inverters, cables, etc.—are not included. At right is a batch of solid state elements in a regulating system.

and for Venus and Mars Vega missions at 160 w.

When permission is granted to use nuclear power sources on unmanned payloads, communications on these payloads no longer will be auxiliary power-limited; rather the problem will change to one of obtaining sufficient heat rejection from the avionic components.

Although the Space Power Group at JPL is not working directly in nuclear reactors for power, according to the Laboratory's "no duplication" philosophy, there is a nuclear reactor effort being conducted by the Laboratory's Physics Section. This group is investigating feasibility of new ideas in reactor technology, which is related to power supplies as the heat source, and is not concerned with hardware.

Nuclear reactor use for power technically is feasible for orbital and space flights due to available control methods, Physics Section scientists say. Indications are that a reactor-carrying vehicle would be launched with control rods keeping the reactor from becoming critical. When orbit parameters are ascertained as meeting criteria for nuclear operations, a command signal could be sent to withdraw the rods, allow the reactor to go critical and start generating power.

Orbit criteria would be based on ensuring that if vehicle deviated from the planned path or had a failure, control rods could be re-inserted in the fission material to stop the chain reaction, and radiation from reactor fuel and other parts of the system subject to dangerous levels would have time to decay before the vehicle could possibly start a re-entry and be destroyed or torn apart by re-entry stresses. This would prevent a major fallout hazard.

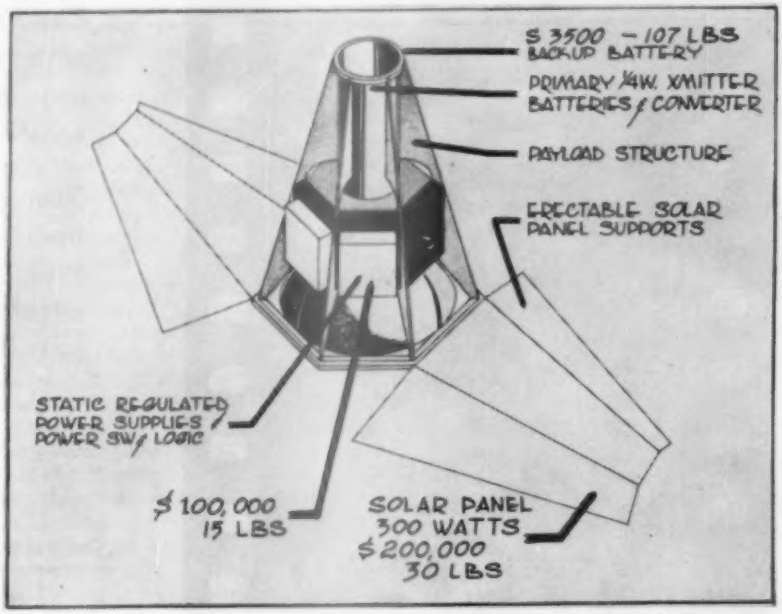
Nuclear reactors for space systems have been in development to meet several power levels. One is for 3 kw. (SNAP II); another is for 30 kw. with expansion potential to 60 kw. (SNAP VIII); a third system now is up for bid with a 300 kw. capability (AW Dec. 21, 1959, p. 23). All three generate power by using reactor heat on a working fluid. The first two are connected to rotating machinery which generates the power, and it is anticipated the third also will be used with rotating machinery to generate power.

Expectation is, according to the Physics Section, that the first reactor actually used in flight will be primarily to generate electrical power for a long-duration, low-thrust propulsion system such as ion or plasma. Auxiliary power would be a byproduct.

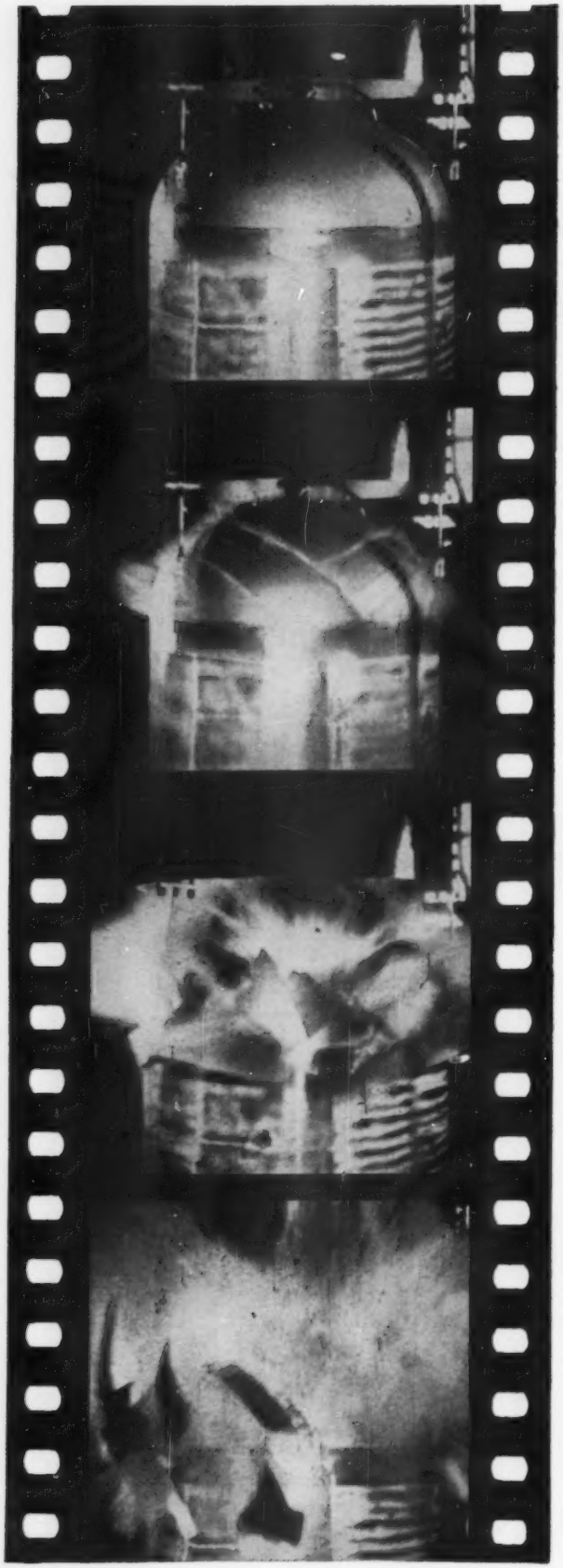
The Physics Section is conducting theoretical investigations on nuclear power systems which would make use of so-called "exotic phenomena," for far-in-the-future applications where advanced performance will be needed.

It also is studying more sophisticated reactor design configurations to yield higher utilization of reactor energy. Two types under investigation:

• **Cavity reactor for propulsion** (which also would supply heat for conversion to auxiliary power), wherein the combustion chamber of a rocket engine is replaced by a chamber containing a critical mass of fission material. Nuclear material is held in place by spinning the chamber to produce centrifugal force, or by some other scheme. A working fluid, such as hydrogen, is passed through the nuclear material, is heated, then ejected through a nozzle to produce thrust such as produced by a conventional rocket engine. Some scientists engaged in original cavity reactor work in 1955 at Atomic Energy Commission's Oak Ridge Laboratory now are doing this work in JPL's Physics Section. Main effort of this group is di-



DRAWING shows a possible solar panel configuration which would be used for a moon landing. This type might be applicable to the Atlas-Agena satellite.



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rected toward solving the gas dynamics aspects of cavity reactors, primarily the problems associated with separating the fission material from the working fluid, and keeping fission material in the reactor.

• **Direct generation** of electrical power in the fission process by separating and collecting the fission fragments. Physics Section points out that this theory is not new, but the technology needed to accomplish it has been in development. However, an in-pile experiment using this theory has been completed on a typical fission-electric cell configuration. Calculations show that a 2% efficiency is obtainable using this concept. JPL and Rand Corp. are cooperating in this work.

Atomic Particles

The Physics Section also is working in atomic particle accelerators, and though efforts now aim at simulating corpuscular environment near the sun, it is expected that later work will involve accelerators as space vehicle thrust generators.

Although current reactors are heating working fluids and using rotating machinery to generate power, solid state devices which translate heat into power without moving parts are under development—the thermoelectric and thermionic devices.

Thermoelectric devices generate electricity by passage of heat through materials, similar to the thermocouple principle. JPL believes this approach is limited because maximum operating temperatures, which are the measure of efficiency, and now are estimated to be 650C to 700C, using materials such as lead telluride.

Thermionic devices generate current by the flow of electrons from a hot cathode to a cold anode, after which they are passed through a resistive load to accomplish work before returning to the hot cathode. Thermionic devices generally are termed thermionic diodes, and are of two types—vacuum diodes and plasma thermocouples. Maximum operating temperature for the diodes now is indicated to be in the order of 1,100C, indicative of their efficiency margin over thermoelectric devices.

At least three to five years of research are necessary before either of these devices can be incorporated into flight hardware to succeed solar panels, according to JPL spokesmen.

Principles of thermionic power generation are that the electrons in the hot cathode develop enough energy from the heat input to overcome the force which tends to hold them in the cathode and is called the "work function." Work function level varies with materials. After electrons have escaped the hot cathode, they have to move to the colder anode. The electrons move through a vacuum, where their passage creates another force or "space charge" which tends to block their crossing.

To enter the anode, electrons again have to overcome a work function, but it is less for the cold anode than the hot cathode. Electrons have a surplus of energy which is used when they pass through the resistive load and accomplish useful work. Magnitude of energy surplus is the measure of efficiency of the diode.

A very small gap, (0.0004 in.), between cathode and anode is used to overcome the space charge problem in a vacuum diode.

The plasma thermocouple has cesium gas sealed in with the anode and cathode, which are spaced 0.006 in. apart. This gas ionizes at the temperatures involved in cathode heating, and the ionization adequately overcomes the space charge problem while simultaneously tending to increase the difference between the work function values of anode and cathode, thus increasing the device's efficiency.

The first heat source for thermionic conversion devices which most probably will be used in flight hardware, JPL feels, is a solar furnace. This is a concave mirror which collects the sun's rays and focuses them into a polygon which has some area left open. The interior facets of the polygon each would contain a thermionic device to convert the heat to electricity. An attitude control system directed by an automatic star tracker would maintain mirror orientation.

Efficiency Increase

Currently, calculations indicate a 5% efficiency for individual thermionic vacuum diodes, but when connected in multiples such as in the polygon-solar-furnace system, efficiency increases to about 15%, JPL says.

Radiation of surplus heat from thermionic devices will pose a problem, just as solar cells face now. Also, avionic components in the regulatory system of the power supply face the heat disposal problem, with increased complications.

JPL's Space Power Group feels that the re-rating of avionic components mentioned earlier should be on the basis of surface temperature, which is proportional to the interior heat of the component materials caused by the passing electrical current. Interior heat causes component deterioration. The relationship of part surface temperature to service life is significant because, without an atmosphere or gravity to maintain convective air current cooling, heat must be conducted away by direct thermal contact between surface of the part and mounting structure.

This posed a new problem when higher power levels than battery-opera-

ted systems were under investigation. It appears that heat transfer capability of materials either is lost or deteriorates severely under space vacuum environment, JPL says.

Another space environment problem affecting power supplies is sublimation and embrittlement of materials. JPL discovered this when a silicon grease was used to provide thermal conductivity between mounting structure and the mica washer which gave electrical insulation to a transistor. Circuit failure was traced to transistor failure caused by overheating when the grease sublimated and thermal conductivity was lost.

One problem facing solid state power supply regulation is spiking, JPL says, which is an unwanted high voltage pulse which appears regularly in the filter circuit, normally at the primary switching converter rate. If care is not taken, JPL engineers point out, these pulses may be equal to the primary switching voltage.

These surges occur every time a diode rectifier turns on, and reacts as noise in avionic components, tending to degrade their performance. Despiking is the term for adequate control of these surges, an activity which gets significant engineering effort.

Spiking does not occur in rotating machinery regulatory schemes, nor with transformers. But transformers cannot be used because they have a fixed input-to-output ratio. A typical space vehicle power supply has voltage from the power source entering the system in a range varying from 23 v.d.c. to 31 v.d.c., but the regulated output voltage must be precise.

Solid State

Another typical power supply situation described by Space Power Group would have the input voltage of 23-31 v.d.c. to be converted to 60 v.d.c. Solid state regulation has the conversion from direct to alternating current first, followed by the increase to the new voltage level, rectification back to direct current, filtering the delivery to the using component. Somewhere in the chain, regulation must ensure output voltage falls within prescribed limits.

One problem is that certain voltages passing through materials are critically affected by atmospheric pressure levels. This relationship of voltage to pressure must be studied. Also, the gas used to provide the power supply systems with an artificial atmosphere has an effect on the relationship between cooling and voltage corona.

Four Squadron Sites Selected for Atlas

Washington—Air Force has announced the selection of support bases for four additional Atlas intercontinental ballistic missile squadrons to complete the facilities that will be needed for the 13 Atlas squadrons programed thus far.

New support bases announced last week are Altus AFB, Okla.; Dyess AFB, Tex.; Walker AFB, N. M., and Plattsburgh AFB, N. Y. Missile launching facilities for the four squadrons will be constructed at 36 sites, nine in the area of each support base. Technical construction of each of the four complexes is estimated at approximately $47 million. Work at each base will require about 24 months.

In previous announcements, three Atlas squadrons have been scheduled for Francis E. Warren AFB, Wyo., and one each for Offutt and Lincoln AFB, Neb.; Forbes and Schilling AFB, Kan.; Vandenberg AFB, Calif., and Fairchild AFB, Wash.

Aeronutronic to Develop Orbit Computing System

Aeronutronic Division of Ford Motor Co. will study design of a system to aid scientists in cataloging and computing satellite orbits under a contract from Air Research and Development Command.

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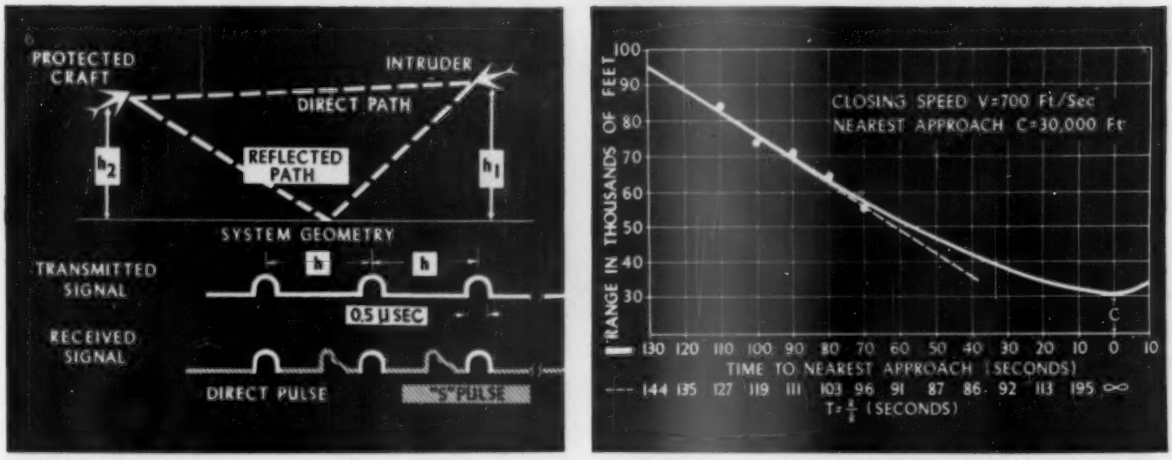


BENDIX airborne collision avoidance system now under test employs transmitter in each aircraft to send out series of pulses whose spacing indicates its barometric altitude, indicating which aircraft pose a potential threat. Distance between such aircraft then is determined by measuring time delay between receipt of direct and reflected pulses as well as own-craft height above ground (left). New Bendix threat warning criteria are based on time to nearest approach between two aircraft and minimum escape time to execute a change of altitude maneuver rather than on predicting probable miss distance and assessing whether it is safe or hazardous. Bendix system computes ratio of range to range-rate, sounds alarm when it reaches preselected value of the minimum escape time (right).

Anti-Collision System Appears Promising

By Philip J. Klass

Washington—Prospects for an airborne collision avoidance system which is economically and operationally feasible appear brighter today than at any time in the last several years, based on recent flight tests of a Bendix Radio development.

In a recent report to the Federal Aviation Agency's Collision Prevention Advisory Group (COPAG), Bendix representatives disclosed that recent tests had been "most encouraging." For Bendix Radio, this is a strong endorsement. The company long has been extremely conservative, even pessimistic, over the prospects of developing a feasible collision avoidance system.

Bendix System

The Bendix collision avoidance system, being developed under FAA sponsorship, is a cooperative type system. This means that both aircraft must be equipped before either can receive a collision warning from the other. However, the Bendix technique permits smaller aircraft to carry lighter-weight, lower-cost equipments which will provide warning to larger, fully equipped aircraft, depending upon the latter to take the required evasive action.

A preliminary Bendix estimate indicates that a full anti-collision system, which can alert other aircraft and also receive and evaluate threat to own-craft, should weigh about 80 lb. (uninstalled) and occupy 1¼ to 2 ATR-size cases. The minimal version, which alerts only fully equipped aircraft, is expected to weigh 25-30 lb. and to occupy a ½ ATR-size case.

Bendix emphasizes that its collision avoidance system is not a complete solution to the air collision problem but rather a compromise answer to a problem that has no complete solution.

Automatic Evaluation

For example, the Bendix system is designed to automatically evaluate the collision threat when the two aircraft are in level flight, climbing or descending.

It cannot make an evaluation of the threat when one or both airplanes are turning. However, without prior knowledge of what action the maneuvering airplane pilot plans to take an instant later, no collision avoidance system can predict whether a hazard exists with 100% certainty, Bendix points out.

Previous Efforts

Previous industry efforts to develop a collision avoidance system generally have been based on an equipment which attempts to predict the "miss-distance" between two aircraft in order to establish whether it is large enough to be considered safe or not. If the miss-distance is too small, an evasive maneuver in the form of a turn is called for.

This approach requires accurate measurement of the relative bearing angle or closing rate between the two aircraft in order to draw the exceedingly fine line between a safe and a hazardous miss-distance. This poses technical problems in turbulent air conditions and makes it difficult to hold system size, weight and cost down to moderate levels.

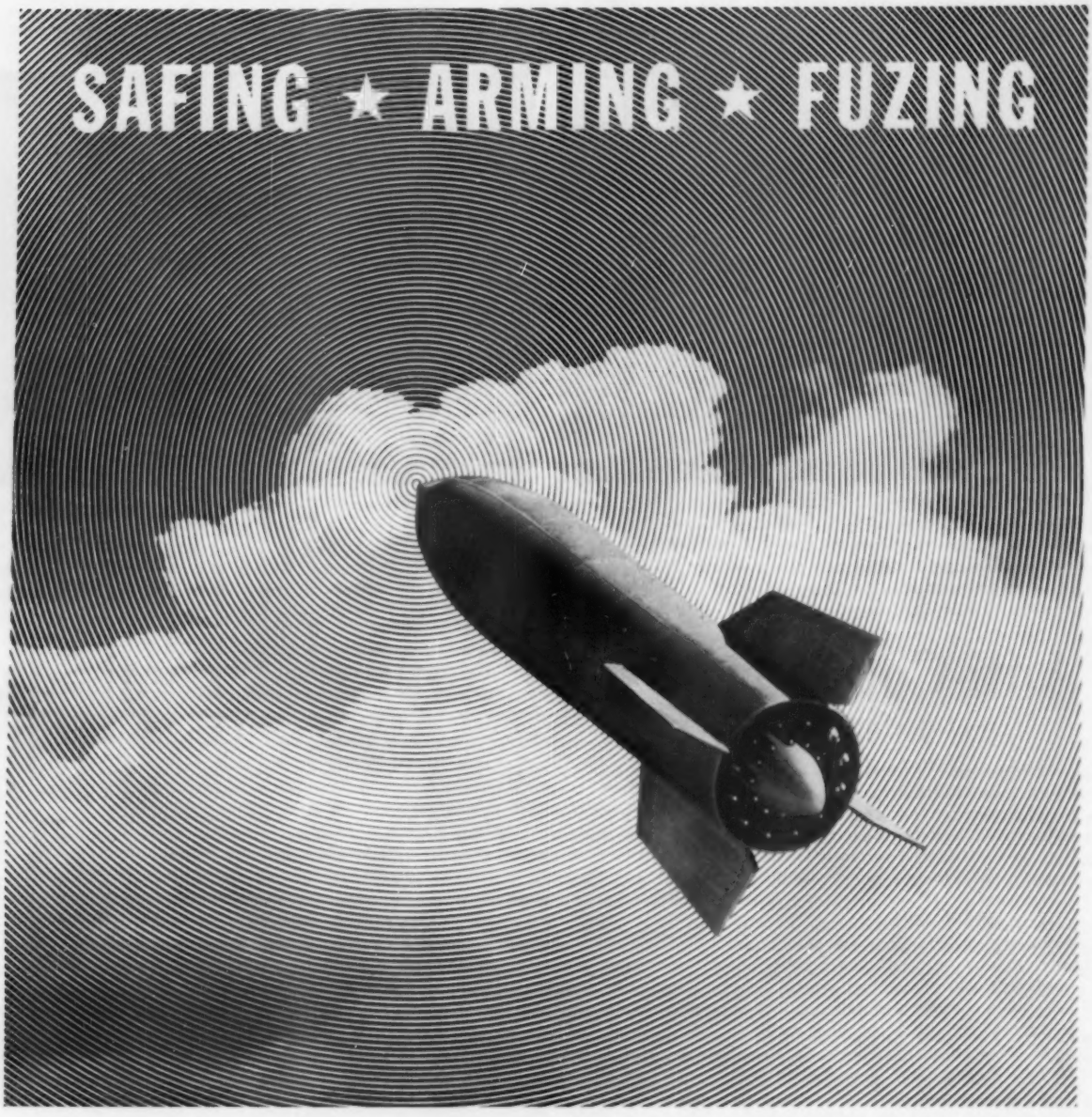
New Criterion

Bendix Radio proposes to use a new criterion for determining whether an evasive maneuver should be made, and it proposes to use a change in altitude (dive or climb) as the escape maneuver. The new criterion is time: time to the nearest approach between the two aircraft and the minimum escape time

COPAG

Federal Aviation Agency's Collision Prevention Advisory Group, known as COPAG, formed early last year, is the central clearing house for airborne collision warning/avoidance system ideas and activities.

The group, which meets regularly at approximately six-week intervals, includes representatives of the FAA, the three military services, the Air Line Pilots Assn., the Air Transport Assn., National Pilots Assn., National Aeronautics and Space Administration, Aircraft Owners and Pilots Assn. and the National Business Aircraft Assn. Robert M. Buck of FAA's Bureau of Research and Development is chairman of the group.



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needed by pilot and airplane to change altitude sufficiently to avoid a possible collision once an alarm is sounded.

For example, suppose that tests show that a jet transport pilot requires at least 40 sec. after alarm to execute a vertical escape maneuver. If a collision avoidance system can detect another aircraft converging at or near own-craft altitude and if it can predict how long before the two aircraft will reach minimum separation, the pilot would want to start an escape maneuver before the "time-to-nearest-approach" equals minimum escape time (40 sec.), regardless of whether the nearest approach might ultimately prove to be a safe or hazardous encounter.

Bendix Radio has proposed a collision avoidance system that operates on this philosophy. If there is another aircraft at own-craft altitude and the separation between them is continuously decreasing, the system calculates how long it will take before their separation reaches a minimum. Then, before the time-to-nearest-approach equals the minimum escape time, the system sounds an alarm and indicates whether the pilot should climb or dive.

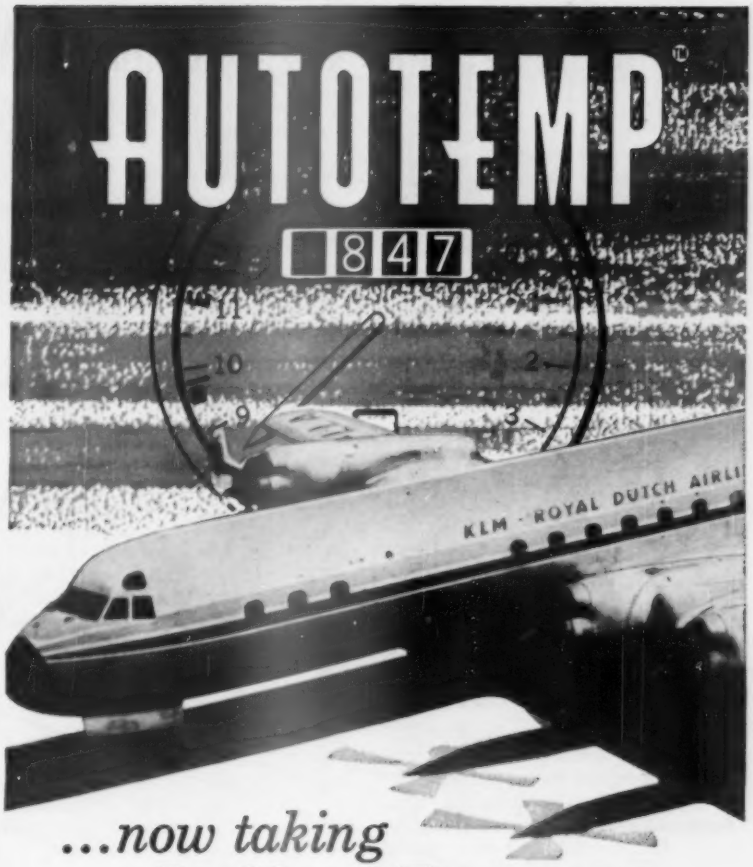
Because the Bendix system does not attempt to predict whether the situation will lead to a "safe-miss" or a collision, the accuracy with which measurements must be made is greatly eased.

The first function which the Bendix collision avoidance system performs is to determine whether there are any other equipped-aircraft at or near own-craft altitude. Each equipped-aircraft would carry a small radio transmitter, operating in the UHF band, which would periodically broadcast a series of perhaps 20 pulses where the spacing between individual pulses automatically varies as a function of the airplane's barometric altitude. The series of altitude-coded pulses might be transmitted every 10 sec.

A fully equipped airplane would also carry a radio receiver which analyzes pulses received from all other aircraft in the vicinity to determine which, if any, are at or near its own barometric altitude. Where sufficient altitude separation exists, no more detailed analysis is required to indicate that airplane is not now a threat. But if one or more aircraft are at own-craft altitude, further analysis is required to determine whether they are a threat.

This much of the Bendix technique is not in itself new or novel. Similar ideas for altitude filtering have been advanced by others.

However, because Bendix does not attempt to predict miss distance to determine whether an escape maneuver is required, it avoids the problem of accurate bearing measurement which has plagued earlier collision avoidance system efforts. Instead Bendix needs to



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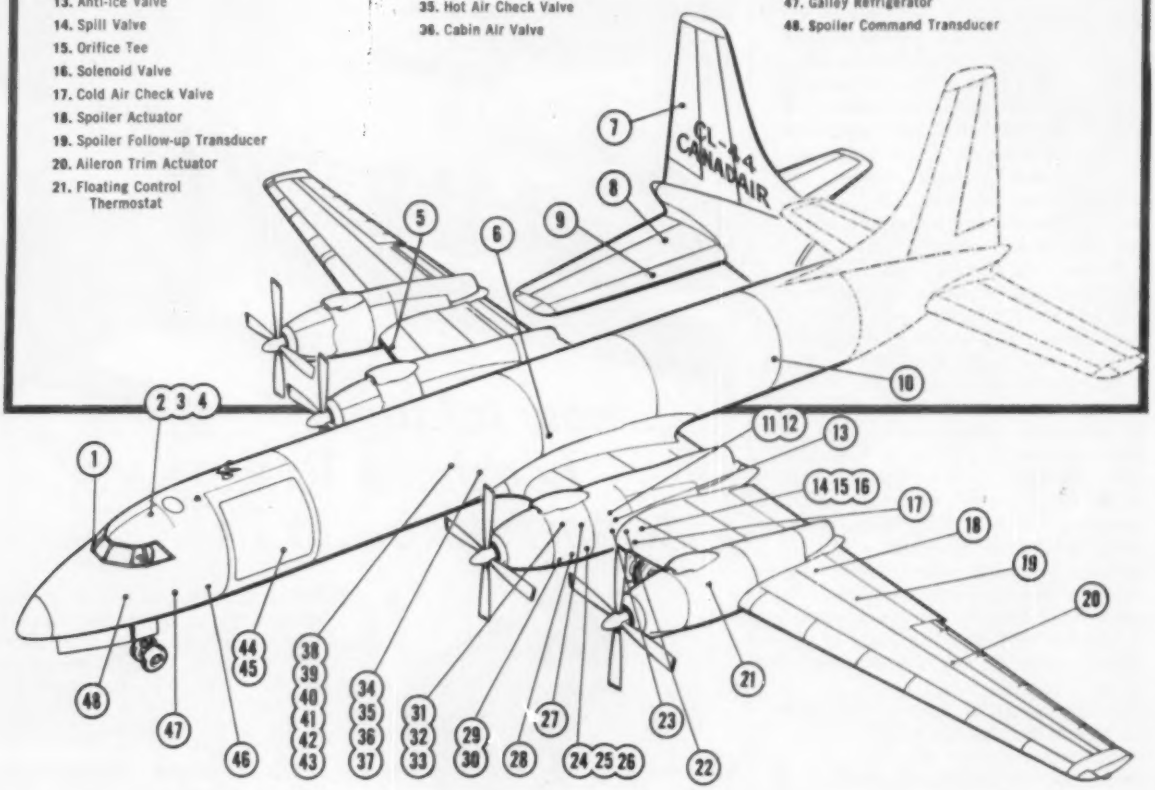

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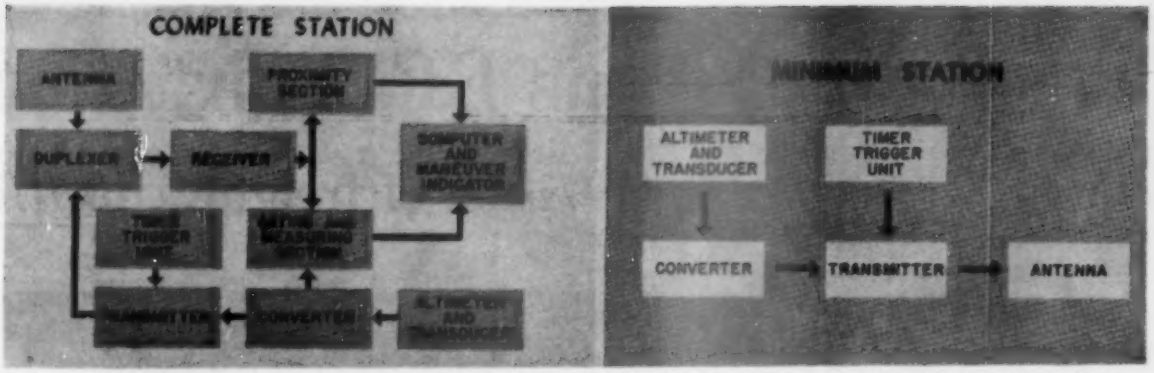


BENDIX collision avoidance system is a cooperative type which requires equipment in both aircraft to protect either. However, technique permits a minimal version for smaller aircraft which alerts fully equipped planes, depends upon them to make escape maneuver.

measure only range between own-craft and other aircraft at or near the same altitude, and the rate at which this range changes with time.

An obvious way to make such measurements would be to equip each aircraft with a DME-type transponder, but this would result in dozens of aircraft each interrogating and replying to one another in a terminal area, raising serious interference problems.

Bendix therefore has selected a more ingenious approach to measuring range between aircraft which not only minimizes the interference problem but also simplifies the collision avoidance equipment which aircraft must carry. This technique, sometimes referred to as "ground-bounce ranging," is being employed by at least one other company for military applications other than collision avoidance.

Ground-Bounce Ranging

For every pulse of energy broadcast by the collision avoidance transmitter aboard one airplane, other aircraft in the vicinity will receive two (or more) pulses.

One is the energy that travels the direct path through the air between the two aircraft. The other is the energy that bounces off the ground, billiard-ball fashion.

The time delay between the receipt of the direct-route pulse and the ground-reflected pulse is a direct function of the distance (range) between the two aircraft and their altitude above the ground, i.e., terrain clearance. If the delay is long, the two aircraft are relatively close. If the delay is short, they are separated considerably.

By measuring the time delay between the receipt of the direct and the ground-reflected pulses and by measuring own-craft height above the ground, it is possible to compute the distance between the two aircraft. Because the collision avoidance system already contains much of the circuitry required for radio altimetry (a transmitter, receiver and timing circuits), Bendix believes it can perform height measurement without appreciable increase in system complexity, avoiding the need for a separate radio altimeter.

When aircraft are flying over mountainous terrain, errors in measuring effective aircraft height can introduce significant errors into the calculated value of distance (range) separating the aircraft.

If a ratio of range to range-rate is used to initiate the escape warning, terrain-induced errors cancel out, Bendix's Dr. J. S. Morrel told FAA's recent COPAG meeting. This conclusion is based on mathematical analysis.

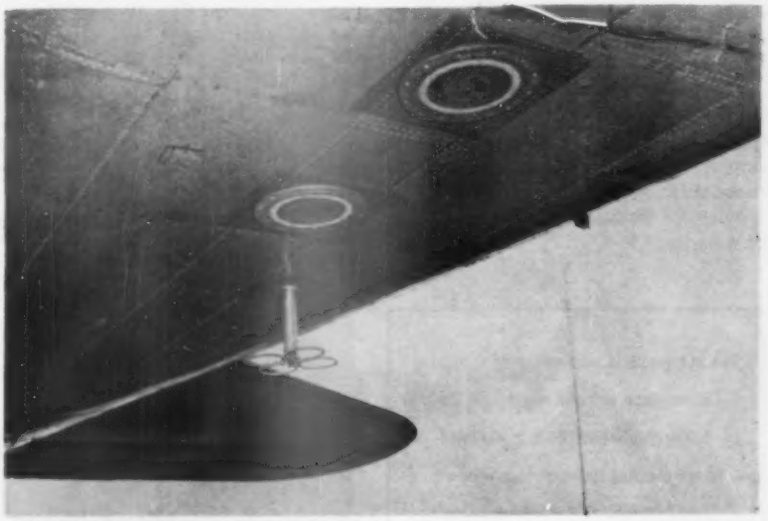
This ratio of range to range-rate, which Bendix calls Tau, has the dimensions of time. It is directly related to the time to nearest approach of the two aircraft. The Bendix system continuously monitors the ratio of range to range-rate.

If it reaches a value of, for example, twice the minimum escape time for the particular type aircraft on which installed, the collision avoidance system will sound the maneuver alarm. Thus for an airplane with a minimum escape time of 40 sec., when the ratio of range to range-rate reaches 80 sec., the escape maneuver alarm will sound. A safety factor of less than 2:1 may be used if an operator prefers to take added risk to minimize the number of escape alarms.

Threat Exists

If an airplane's collision avoidance system determines that a threat exists, it will signal for an escape maneuver, selecting a climb or a dive depending upon whether it is at a higher or lower altitude than the other aircraft. (The other aircraft's barometric altitude is known from its transmitted pulse spacing.)

If both aircraft are equipped with a transmitter and receiver, each collision avoidance system should normally signal for opposite maneuvers. How-



SMALL CLOVERLEAF antenna required for the Bendix collision avoidance system is shown installed on belly of a DC-3 used in company's flight tests. The antenna provides a horizontally polarized hemispheric type of radiation pattern.

Titanium trims DC-8 airframe

(equals 5 passengers, or 1/2-ton of freight...*for life!*)

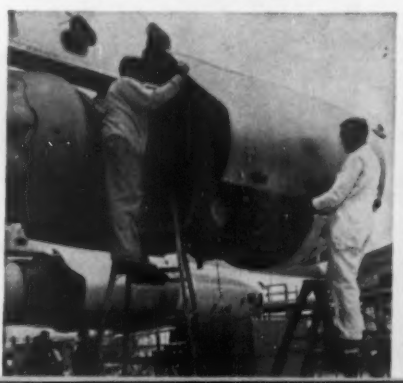
DOUGLAS AIRCRAFT COMPANY, INC., *has never built an airplane that failed to show a profit for its operators. Based on the experience of United Air Lines, the first carrier to fly the airplane, the latest Douglas ship, the DC-8 jetliner, indicates it will push this record forward. Here's how use of titanium contributes to the total efficiency of the airplane and what that efficiency means in dollars and cents.*

The flyaway airframe of the DC-8 jetliner provides its operators a basic economy almost anomalous in current design: payback on every flight without research or development costs to be amortized. That's how Douglas engineers state the value of titanium in achieving a minimum weight airframe structure.

Primarily an aluminum ship, the DC-8 offered few possibilities for weight savings during design. But where weight could be reduced – in pods and pylons, rip stoppers and door doublers–titanium was selected: –600 pounds of commercially-pure grade Ti-75A for pods and pylons; 330 pounds of Ti-6Al-4V titanium alloy grade for rip stoppers and door doublers; 15 pounds of miscellaneous titanium forgings. Metal is supplied by Titanium Metals Corporation of America.

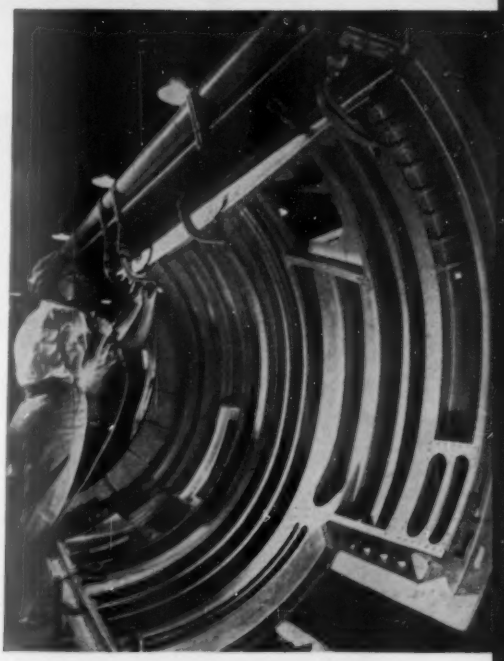
The net result is elimination of a half-ton of needless airframe weight for the 5,000 flights each DC-8 is expected to make during its seven-year write-off.

TITANIUM ACCESS DOOR, through which DC-8 engine will be serviced, is installed on the aircraft by two Douglas Aircraft Company, Inc. employees. Pods of the DC-8 have been so designed that titanium will completely seal off any engine fire



TITANIUM RIP-STOPPERS play essential role in Douglas fail-safe approach to airplane construction. DC-8 uses 330 pounds of Ti-6Al-4V alloy titanium produced by Titanium Metals Corporation of America

by 945 pounds



TITANIUM ACCESS PANEL which covers engine in DC-8, complete with titanium details, measures 102″ by 76″ and weighs 80 pounds. Cumulative tolerances are controlled so closely at Ryan that each door is interchangeable with any pod built for a specific airline. 600 pounds of titanium (TMCA grade Ti-75A) are used in DC-8's pods and pylons

Interpretations of the value of weight savings include:

- DOUGLAS AIRCRAFT: "The 1,000 pounds (of weight saved) are equivalent to five passengers and their luggage for the entire life of the airplane."
- UNITED AIR LINES: "At the very least, the weight saved by titanium is equivalent to a half-ton of cargo. At mail rates, this would amount to a potential of $525 for each coast-to-coast flight."

Why titanium?

Titanium, with a density of 0.163 lb/cu. in. is produced in strengths equal to or surpassing steel on a strength-weight basis. Its resistance to atmospheric corrosion is permanent.

The reliability of titanium has been established with demonstrated clarity. Examples:

- DOUGLAS has employed titanium in every commercial transport since its first DC-7, where titanium in firewalls, nacelles and landing gear doors yielded 200 pounds of weight savings.
- PRATT AND WHITNEY AIRCRAFT reports that more than one million flight hours have been accumulated by more than 5,800 P & WA JT-3 and JT-4 engines using titanium components without a single failure of any titanium part, either through corrosion or mechanical damage. Both engines have been specified for the DC-8.
- Alluding to titanium's reliability as its "sleeper property," W. Stuart Lyman, Principal Metallurgist, BATTELLE MEMORIAL INSTITUTE, made this comment in a lecture in Los Angeles March 19:

  "We have talked with metallurgists from three large users of titanium recently. To a man, they reported that once titanium passes receiving inspection, gets fabricated, passes final inspection, and gets assembled into the airplane, it is usually never heard from again."

Is titanium competitive in price?

RYAN AERONAUTICAL COMPANY, which fabricates the bulk of the titanium assemblies employed in the DC-8, commands industry-wide respect for its skill of craftsmanship and the attention to detail it brings to every job. Example: To guarantee maximum cleanliness, Ryan's DC-8 final assembly building in San Diego has been so constructed that no doors or windows open in the direction of prevailing winds.

While overlooking no opportunity to impress upon employees' minds that titanium metal costs more than steel, Ryan has developed manufacturing techniques to fabricate titanium at prices roughly equivalent to steel's. The spread between "input metal" and completed assemblies is thus drastically narrowed since fabrication costs are, of necessity, far greater than raw material costs.

Highlighting titanium's fabricability is Ryan's production of the access panels which cover the DC-8 engines. These panels —literally the doors through which engines will be serviced for life — are made from three sections of 0.016″ Ti-75A, 36″ x 72″, hot stretch-formed and welded together to form the skin of the completed door. Details, such as stringers, channels, ribs and frames, are then welded or riveted to the skin. The completed product weighs 80 pounds and measures 102″ long by 76″ in the curvature. Control of tolerance (cumulative tolerances are ±0.005″) is so highly developed at Ryan that these massive-appearing access panels are interchangeable with any pod built for a specific airline.

Where does titanium belong?

Titanium metal, built into the DC-8 as a basic design material, has been used in a variety of civilian and military applications in a direct volume-for-volume substitution for heavier materials to capture weight savings sufficient to permit improvements in systems or payload capacity.

Although such weight reduction programs and the attendant dollar value must be viewed in relation to the specific application, titanium's permanent resistance to atmospheric corrosion yields dividends immediately apparent to operators of commercial carriers. It means 8 to 10 trouble-free hours operation each day when maintenance means not only repair costs, but also downtime of expensive equipment.

In pods, pylons, landing gear doors, bulkheads, stringers, and a host of similar parts, titanium's weight savings are measured in *payback*. In projects such as solid and liquid propelled missiles, titanium's weight savings are measured in *payload*.

Why Titanium Metals Corporation of America?

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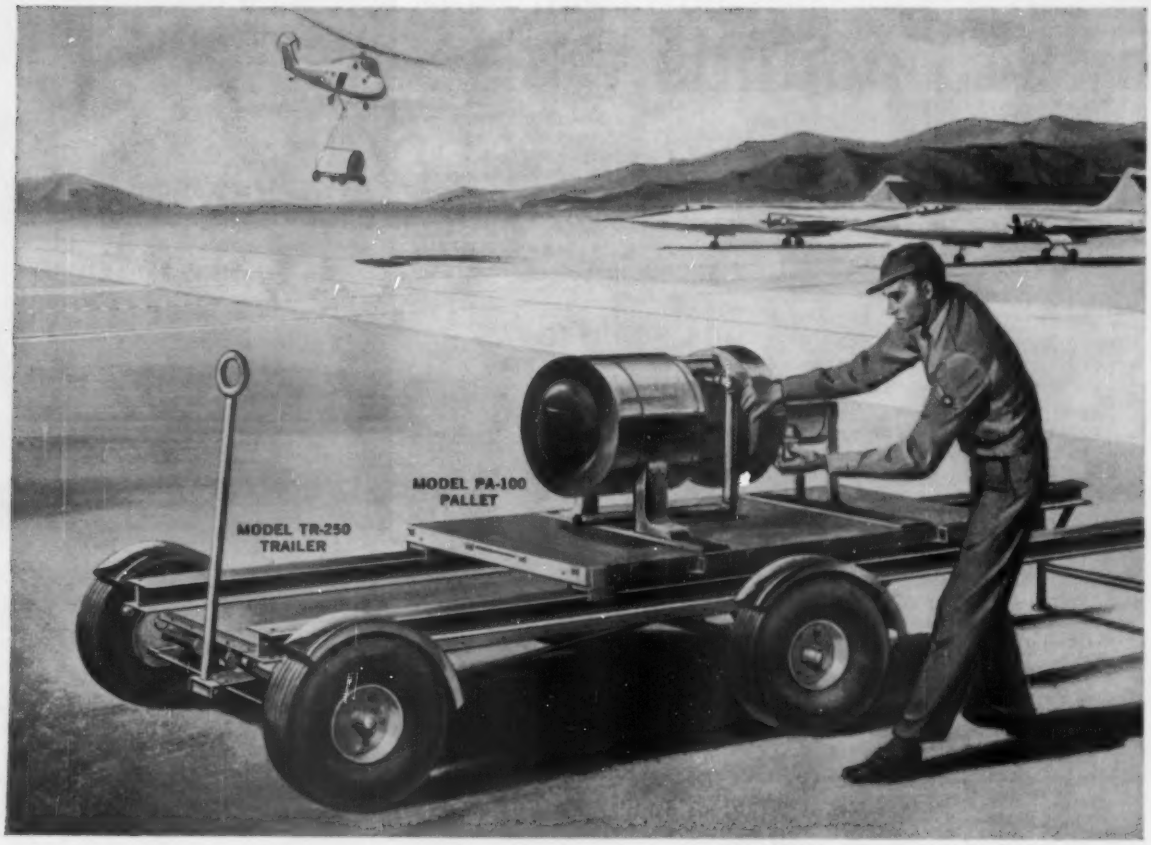

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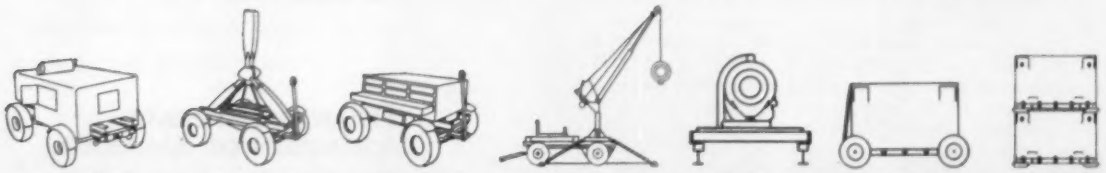


GENERATOR · COMPONENT HANDLING · WORK BENCH · JIB CRANE · ENGINE REPAIRS · CONTAINER · SUPPLY TRANSFER

Saturn Static-Firing Results to Be Recorded in Blockhouse

Static-firing data on Saturn 1.5-million-lb. thrust booster will be recorded in instrumentation room of Army Ballistic Missile Agency's test laboratory blockhouse at Huntsville, Ala. Master control panel in center of room will control tape and strip chart recorders paneled along walls. ABMA is developing Saturn for National Aeronautics and Space Administration.

ever, if both aircraft are at the identical altitude, the aforementioned basis for selecting the evasive maneuver cannot be used.

Present thinking at Bendix is that the first airplane collision avoidance system to arrive at the conclusion that a threat exists and that both aircraft are at the same altitude can make an arbitrary choice of maneuvers, but will immediately tack on a distinctive pulse to its normal broadcast which indicates its choice of maneuver so the other aircraft collision avoidance system will know to select the opposite maneuver.

Additional pulses may also be used to indicate when aircraft is climbing or descending, as distinguished from level flight, in order to predict a potential collision threat between an ascending and a descending airplane. Another pulse code may be used by minimal-equipped aircraft to indicate that they do not have self-warning capabilities and hence cannot be expected to make an evasive maneuver.

Bendix recently completed the first phase of an FAA-sponsored program intended to evaluate the feasibility of ground-bounce ranging, which is the cornerstone of the company's proposed collision avoidance system. Flight tests were conducted at two different frequencies: 440 mc. and 1,630 mc. The 440 mc. transmitter had a peak power of 1 kw., the 1,630 mc. transmitter had an output of 3.5 kw. Experimental equipment was installed in a Bendix DC-3 and a Beechcraft.

More than 25 hr. of flight tests were conducted at altitudes of 5,000, 8,000 and 12,000 ft. over smooth terrain, mountainous terrain and over water. Over rough terrain multiple reflections of the ground-bounce signal were received and in some instances these reflections lasted long enough to interfere with the next direct pulse, L. R. Yates reported to COPAG. However, by increasing the spacing between successive transmitted pulses to around 25 to 50 microseconds this problem can be eliminated, Yates said.

Tests indicate that 440 mc. offers far better performance than 1,630 mc., with the latter being about 15 db. lower in reflected signal level. Small horizontally polarized cloverleaf antennas were used in the aircraft to provide hemispheric radiation patterns. The 440 mc. antenna measures about 8 in. in diameter; the 1,630 mc. antenna measures approximately 3 in. in diameter.

The next step in the Bendix flight test program is to check the accuracy of the ground-bounce ranging technique by means of extremely precise transponders installed in two aircraft. These tests are under way.

Bendix currently is negotiating with FAA for a contract to construct and flight test two complete collision avoidance systems incorporating computers for evaluating the threat and generating the escape maneuver signal. These tests are expected to begin this summer.

If the Bendix collision avoidance technique continues to show promise, the FAA, the military services, the airlines and general aviation will face this fall the question of whether to adopt the Bendix technique as the industry standard. An inherent disadvantage of any cooperative-type system is the fact that there is room for only a single type because aircraft cannot afford to carry multiple systems.

Barring some new approach to collision avoidance equipment design, or shortcomings disclosed by forthcoming flight tests, the Bendix technique may well become the industry's standard.

This would be ironic because Bendix was one of the last of the major avionic manufacturers to propose a solution to the air collision problem.

Communications & Electronics

Separately procured Fiscal 1961 Defense Department budget request
(in millions of dollars)
(new obligational authority)

	FY 1959	FY 1960	FY 1961
Air Force	$854	$810	$761
Navy	$100	$315	$179
Army	$120	$151	$148
Total	$1,074	$1,276	$1,088
	Expenditures		
Air Force	$604	$546	$766
Navy	$153	$196	$161
Army	$185	$164	$169
Total	$942	$906	$1,096

Low Temperature Coils Cut Maser Size

By Barry Miller

Lexington, Mass.—Size, weight and power requirements of solid-state Masers may be reduced by superconducting electromagnets developed here recently by scientists of the Lincoln Laboratory of Massachusetts Institute of Technology.

Made of coils of niobium or lead which become superconductive at the near absolute zero temperatures at which Masers usually operate, the compact electromagnets can supply stable magnetic fields for many hours at liquid helium temperatures with practically no power consumption.

Solid-state Masers are extremely low-noise microwave amplifiers which are finding applications in radar, radio astronomy and communications (such as the National Aeronautics and Space Administration's Project Echo). They operate at liquid helium temperatures (near absolute zero) to achieve the utmost in their low-noise capabilities.

To the liquid helium bath in which the Maser cavity and crystal are immersed, Lincoln scientists have now added superconducting solenoids which, in one case, supplied a magnetic field of 2,000 gauss for successful operation of an L-band Maser. Encouraged by these early results, they plan to use the superconducting electromagnets in a projected 8-mm. Maser (AW Jan. 11, p. 99), according to a Lincoln source.

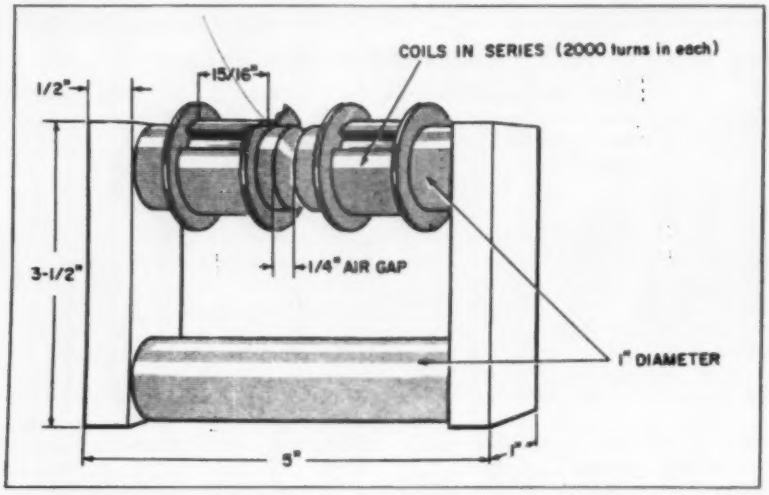
Normally, magnetic fields are externally applied to the helium bath's container to separate the atomic energy levels of the Maser crystal within the liquid coolant. Some Masers have been operated at zero magnetic fields at the Willow Run Laboratories of the University of Michigan, but their use is restricted to a limited number of frequencies dictated by the Maser crystals.

Consequently, magnetic fields must be supplied and this requirement frequently means heavy, bulky magnets. One superconducting solenoid, on the other hand, which supplied 4,300 gauss at 4.2K, weighed 10 oz. and measured 5 in. in length and 2 in. in diameter, according to S. H. Autler in a Lincoln report on the development. The solenoid contained 11,600 turns of niobium, a metal which resembles tantalum and which loses its resistive properties when cooled slightly below 8.5K.

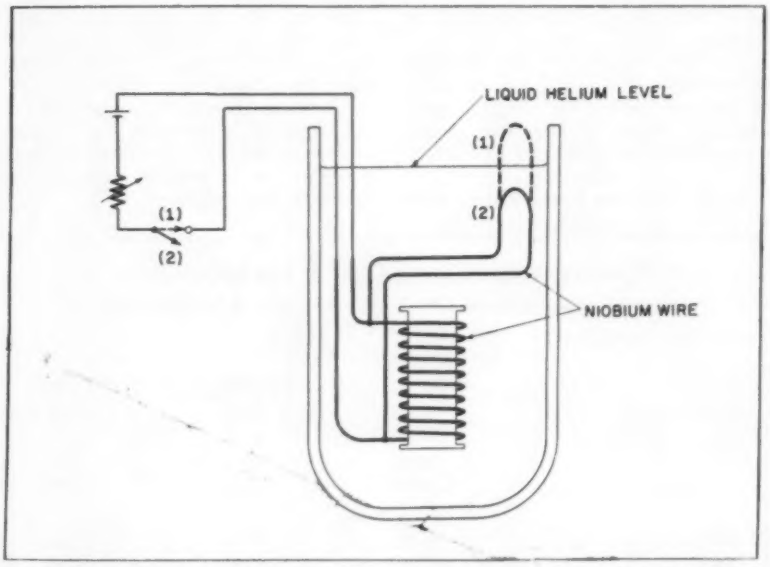
The superconducting electromagnets made at Lincoln are of two general types: the air core solenoid, previously mentioned, which is made of many turns of insulated niobium or lead wires; and iron-core magnets with one or more turns wrapped around a ferromagnetic core which has an air gap. The latter type, Autler says, can supply sizable fields—up to 14 kilogauss have been measured.

Operation of a typical superconducting electromagnet (solenoid) as it might be used in a Maser is as follows: wound on a hollow cylinder, the niobium-wire solenoid is immersed in liquid helium and is therefore resistanceless, or superconducting. It is connected by copper leads to a power source and rheostat outside the liquid. A strand of niobium wire, spot-welded across the solenoid, is partially drawn out of the helium bath. Consequently, it is at a higher temperature and has a finite value of resistance. It does not draw any steady-state current in this position.

When the current supply is adjusted to a desired value by the rheostat, the shunting niobium strand is submersed into the bath. It loses its resistance and forms a closed superconducting circuit with the solenoid. The flux in this superconducting circuit cannot change, Autler points out. The power supply can be disconnected, and the current will flow continuously without any power loss. In fact, the only power losses are the dissipation in the copper



IRON-CORE superconducting magnet used in laboratory tests is dimensioned to indicate size of device studied by scientists at Lincoln Laboratory.



SUPERCONDUCTING solenoid is energized by external power supply which is disconnected after niobium wire is dropped into position (2) thus establishing a superconducting circuit which supplies stable magnetic field.

leads to the solenoid and in the external power supply circuit during the initial setting of the solenoid's current.

The upper value of a magnetic field supplied by the superconducting solenoid is limited, Autler says, because the inner turns of the solenoid are subjected to a field which can exceed the critical magnetic field and quench superconductivity.

Lead-wire solenoids fabricated at Lincoln produced fields of about 500 gauss at 4.2K. Niobium appears to be better, however, in that it has higher critical fields and better mechanical properties than lead.

Much greater fields can be produced, however, with air-gap, iron-core electromagnets. Although superconductivity is again quenched when the inner wires are subjected to fields in excess of the critical field, the field in the air gap can simultaneously be higher by a factor of the ratio of the lengths of the coil to the air gap.

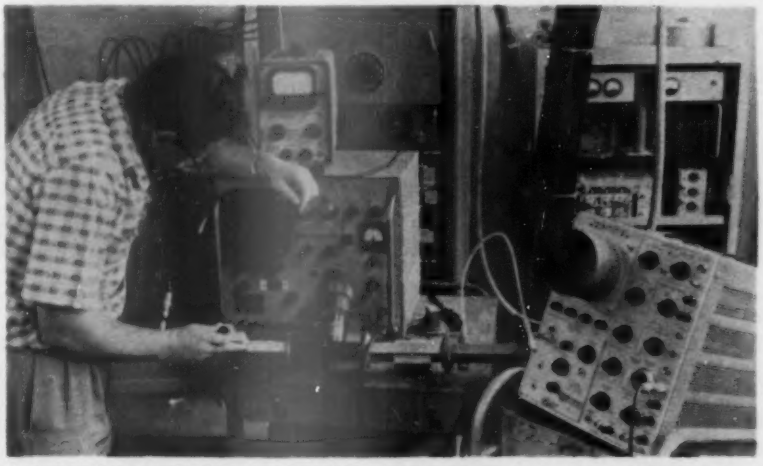
For optimum design of the magnet a balance must be struck between two opposing design considerations. These are a desire to keep the coils separated from the gap so they are not exposed to bringing flux and quenching at lower fields and keeping them sufficiently close to the gap to provide coil flux through the gap and to prevent core saturation at low gap fields.

Five-pound iron-gap superconducting electromagnets which required four liters of liquid helium for cooling from 77K have been made at Lincoln.

Better superconducting electromagnets should emerge from work along the following lines, according to Autler:

- **Higher fields for solenoids** are possible with materials which have higher critical fields if they can be properly drawn into wires. Niobium nitride, for example, has a transition temperature (zero magnetic field) at 16.2K and at a reduced temperature of 13.5K it has a critical field of 9,000 gauss. With improved strain characteristics, niobium wire might provide critical fields of 8,000 gauss at 4.2K.
- **Higher fields** in narrow-gap magnets, approaching the saturation value of iron (approximately 25 killogauss) are possible, and still higher fields are conceivable by using pole tips made of rare-earth metals which become ferromagnetic at low temperatures.
- **Lighter magnets** might be made with wires having high critical fields which would permit coils of shorter length to be placed closer to the air gap.
- **Higher fields** in large gap magnets should be possible with a better distribution of iron and more efficient use of helium vapor.
- **Horizontal fields** may be obtained by Helmholtz-like pairs of coils and these fields can be rotated with orthogonal sets of coils.

MISSILE GUIDANCE radar for Terrier missiles are mounted in barbettes and readied for tests at MacArthur Field, Long Island. Searchlight-shaped antennas on each barbette are for range acquisition and the smaller dish-shaped antennas (arrow) are for capture.



MAGNETRON OUTPUT of the SPG-55 transmitter is checked with specially developed spectrum analyzer to determine generated spectrum, and possible presence of high side lobes. This check can be run remotely.

Terrier Guidance Radar Tests Start

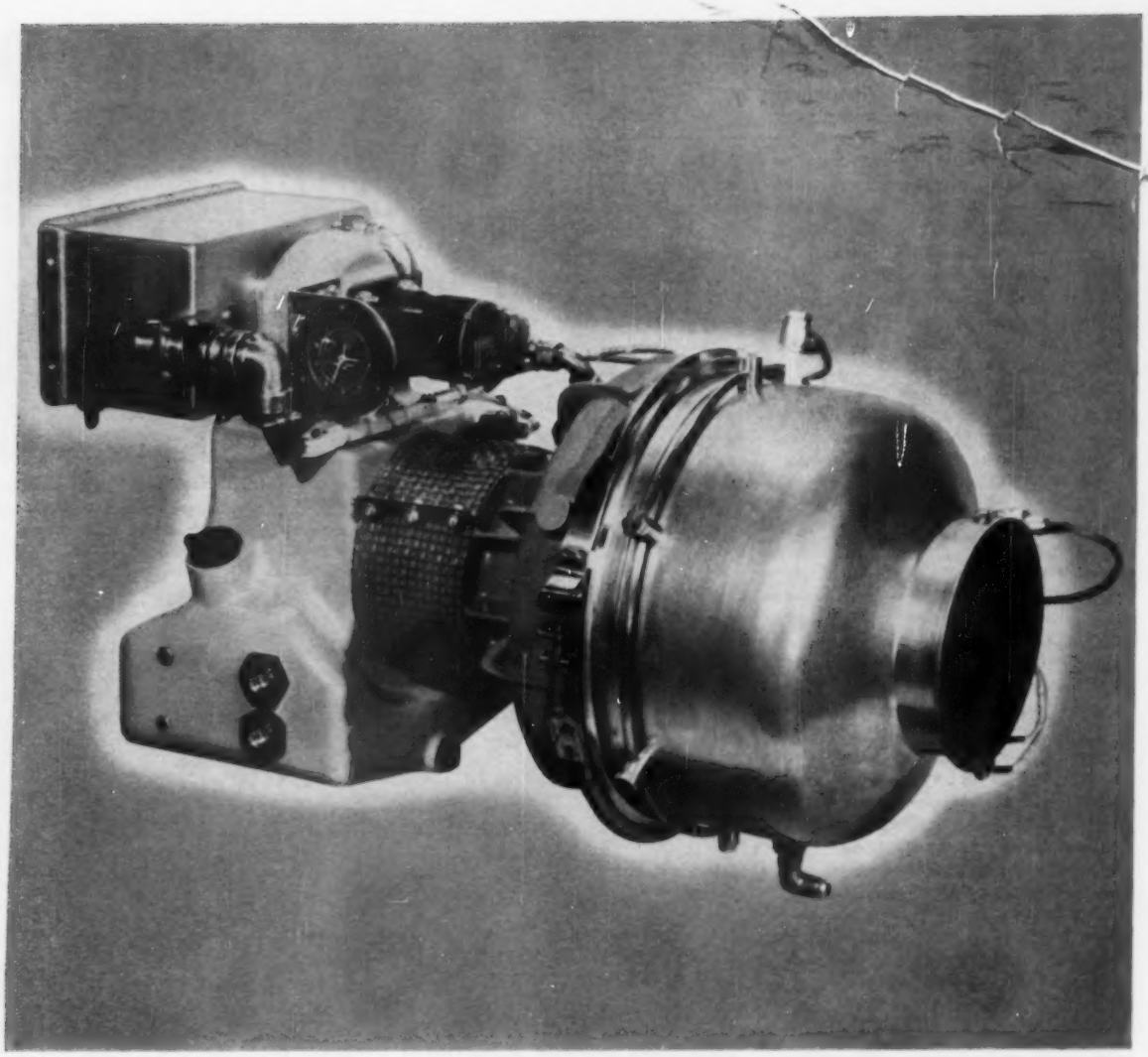
Great Neck, N. Y.—Extensive radar testing facilities for the SPG-55 Terrier missile guidance radar are now in operation at Sperry Gyroscope Co.'s MacArthur Field plant.

Involving an investment of about $2 million, the facilities include nine radar barbettes, a 30 x 200 ft. building for testing above and below deck equipment, a target testing tower and a building for power and distribution system.

These facilities are supported at Sperry's main plant by an antenna pattern measuring range with associated equipment.

Operating conditions and power requirements of the ships which are or will be equipped with the Terrier are duplicated throughout the test system. Special test equipment, including a spectrum analyzer, range calibrator and wattmeter bridge for measuring system parameters to required accuracies are included in the test facilities.

Terriers are now operational on two guided missile cruisers, the USS Boston and the USS Canberra, and on two guided missile destroyers, the USS Gatt and the USS Dewey. Future vessels which are expected to be armed with Terriers include two Forrestal-class aircraft carriers, three guided missile cruisers, a nuclear-powered guided missile carrier, 19 guided missile frigates, a nuclear-powered guided missile frigate, and a nuclear-powered aircraft carrier.



HELICOPTER APU

New Solar gas turbine 80 hp APU is only 12½ in. in diameter x 25 in.—weighs 59 lb

SOLAR'S NEW gas turbine-powered helicopter APU occupies only 2 cubic feet—yet provides hydraulic or electrical power for complete checkout, for ground power and to start main propulsion engines. It makes helicopters completely self-sufficient, able to operate from remote locations with no ground support.

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Titan gas turbines are setting new standards of performance and reliability as propulsion units for one-man helicopters, in portable electric generators and in other applications. For details, write to Dept. G-180, Solar Aircraft Company, San Diego 12, Calif.

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FILTER CENTER

▶**Gallium Arsenide Promising for Diodes**—Gallium arsenide tunnel diode developed by General Electric, which operates at frequency of 4,000 mc. and shows promise of operating above 10,000 mc., also gains other advantages from using the new compound semiconductor material. For example, gallium arsenide tunnel diodes exhibit peak-to-valley current ratios as high as 60:1, compared with only 14:1 or less for tunnel diodes made of germanium, General Electric says. Also, the gallium arsenide diodes have a voltage swing of up to 1.2 v., compared with only 0.45 v. for germanium and 0.75 v. for silicon. New material gives current densities of 5,000 to 10,000 amp. per square centimeter, approximately the same as 12-gage house wire. These factors should give gallium arsenide tunnel diode four times the power handling capacity of germanium devices, General Electric says.

▶**Loran-C Shows High Accuracy**—An airplane or ship using Loran-C (formerly called Cytac), can determine its position to within 800 ft. 95% of the time when operating as far as 900 mi. away from one of the three transmitters, according to results of measurements made over period of a year on a system installed along U.S. East Coast. Loran-C also is operating in the Mediterranean and further installations are planned. Using ground-wave propagated signals, Loran-C provides high precision fixes out to ranges of 1,400 naut. mi. during the day, or out to 1,000 naut. mi. at night. Operating from sky-wave signals, system can be used out to distance of 1,800 naut. mi. during the day or 2,300 naut. mi. at night with errors of about 2-3 mi. Loran-C is a low-frequency (100 kc.) version of the older Loran-A which employs phase comparison techniques to provide the increased accuracy. Like the British Decca system, Loran-C is a hyperbolic navigation aid. Recent evaluation was conducted by Jansky and Bailey, Inc., Washington, D. C., for Office of Naval Research under Coast Guard contract. System was originally developed by Sperry Gyroscope Co. under Air Force sponsorship (AW Apr. 15, 1957, p. 101).

▶**Flexible Radar Energy Polarizer**—New device which makes it possible to generate a wave of any desired polarization (linear or elliptical) that can be caused to rotate at any angular rate without loss in signal power has been developed by Naval Research Laboratory Radar Division. The NRL device accepts any

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Radiation Detector

Silicon radiation detector, battery and amplifier are contained within single tube. New device can pick up particles 1,000 times faster than previous detectors, according to developers, Hughes Aircraft Co.

arbitrary input polarization and resolves it into components of vertical, horizontal, right-circular and left-circular polarizations which are available at four different wave guide ports. Relative amplitudes of these components determine the input polarization. Unit has provision for local oscillator injection to permit linear conversion to an intermediate frequency in mixer diodes attached to the four output ports.

▶ **Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include:

• **Texas Instruments** will develop and produce 24 telemetry systems for Centaur space vehicle under contract to Convair. The FM/FM telemetry systems must operate for 500 hr. continuously without adjustment. Company also has received contract from Boeing for 37 telemetry systems to be used on Bomarc missile. System provides 45 PDM/FM/FM channels.

• **Westinghouse Electric Corp.**, Electronics Division, will build three-dimensional surveillance radars for Air Force under a $15 million contract from Rome Air Materiel Area. Radar will employ a 30-ft. Paraballoon air-inflated antenna weighing about 2,200 lb.

• **Land-Air, Inc.**, Chicago, will provide engineering and instrumentations services to Army White Sands Missile Test Center under $7 million contract.

• **Navy has awarded** six contracts totaling more than $13 million, for production of sonobuoys to the following six companies: General Electric, $3.3 million; Hazeltine, $4.3 million; Hoffman, $1.3 million; Magnavox, $1.3 million; Motorola, $2.3 million; Sanders Associates, $1.3 million.

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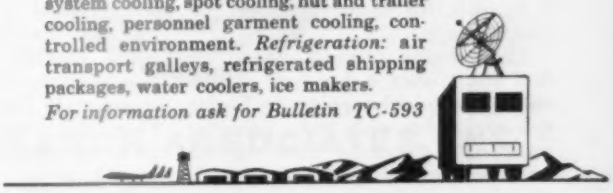
For information ask for Bulletin TC-593



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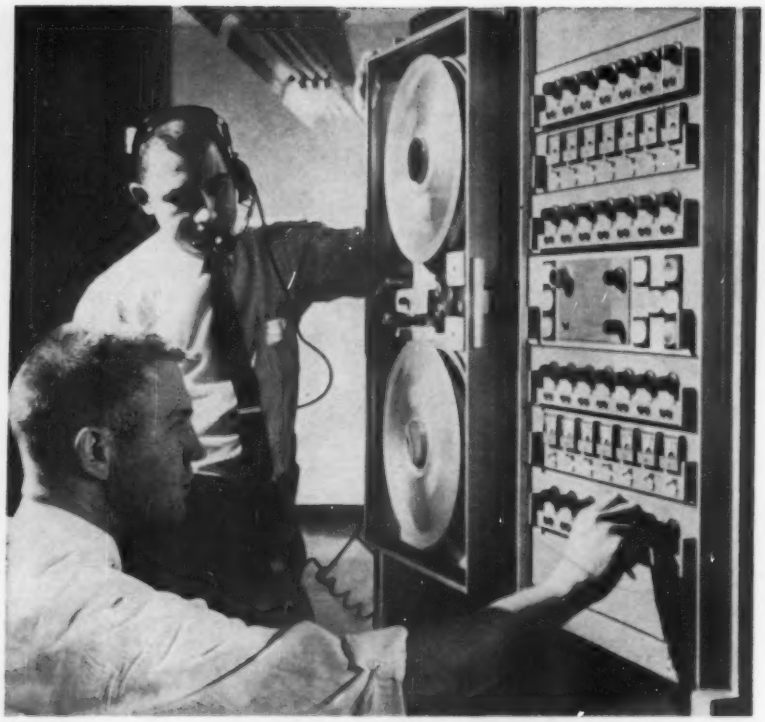

WIDEBAND tape recorder to be used in Minuteman ICBM flight tests has frequency response from 300 cycles to 250 kilocycles. Subsequent models will operate up to 500 kc. The all solid-state tape recorder was developed by Ampex Corp.

Ampex Designs Wideband Recorder To Collect Minuteman Flight Data

Redwood City, Calif.—Transistorized, wideband tape recorder, which will record telemetry data during flight tests of the Air Force's Minuteman solid-propellant ICBM, has been delivered to Boeing Airplane Co. by Ampex Corp., which developed the device.

The first of 17 data recorders which Ampex is supplying for the Minuteman program has a recording frequency range of 300 cycles to 250 kilocycles, at a tape speed of 60 in. per sec. In subsequent models, the upper recording limit will be raised to 500 kc. by increasing tape speed to 120 in. per sec.

Amplitude response is flat to within 3 db. over the frequency range, the company says.

The recorder provides up to 14 data tracks when a 1-in.-wide tape is used. The model supplied to Boeing will use a ½-in.-wide tape, providing seven data channels. Three of the tracks will be used to record pulse code modulation (PCM) data, while the remaining four will be used for conventional FM/FM telemetry data. An additional track for recording operator voices is provided which occupies only 0.005 in. width along one edge of the ½-in. tape; twice this width on the 1-in. tape.

The recorder is the first all solid-state analog-recording unit developed by Ampex. Transistorization is expected to improve over-all reliability as well as eliminate long warm-up time previously required. Design objective was to have the recorder operate for 750 hr. without failure or departure from specified performance. The recorder was developed by Ampex with its own funds and will be added to the company's standard product line, it says.

In addition to standard tape transport speeds of 7½, 15, 30 and 60 in. per sec., the recorder has a high-speed search capability which permits the tape to be moved in either direction at speeds up to 200 in. per sec. A normal 14-in. reel, using Mylar tape, provides 24 in. of recording time at 60 in. per sec.

The machine is equipped with air guides which provide a thin film of air to prevent damage to recorded data when the tape is installed or removed from the recorder.

NEW AVIONIC PRODUCTS

Instruments

• **Push-button generator** for triggering or gating logic systems provides negative 4-v. 0.1 microsec. pulse. Supply voltages and currents are—4 v., 1 ma., + 10 v., 50 ma. Harvey-Wells Electronics, Inc., East Natick Industrial Park, East Natick, Mass.

• **Phase angle meter,** Model VM-204, available for use at any of three frequencies from 60 cps. to 4.5 kc., as specified by user. Measurement range is 1 mv. to 300 v., full scale, in 12 steps. Meter provides independent nulling of in-phase and quadrature components, harmonic rejection greater than 55 db., and nulling sensitivity of 10 microvolts. Designed for bench or rack mounting, meter measures 19 in. x 5¼ in. x 9 in. North Atlantic Industries, Inc., 603 Main Street, Westbury, N. Y.

• **Magnetic tape** recorder/reproducer, Type 5-752A, operates in five selectable modes of recording and playback—analog, FM, PDM, CM (compound modulation) and digital. Changeover is accomplished by plugging in appropriate signal amplifier. Current amplifiers, accessible from front of console, boost reproduce signal output to adequate level for parallel driving of oscillograph galvanometers, chart recorders, and other readout devices. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Telemetry

• **PCM telemetry system** multiplexes and encodes 64 analog channels, and processes five 8-bit parallel digital data channels besides a serial digital data channel at nominal bit rate of 200 kc. High-speed multiplexer handles high

and low level data or combination of both with single low-level amplifier. System weighs 25 lb. and is packaged in ½ cubic foot. Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 9, Tex.

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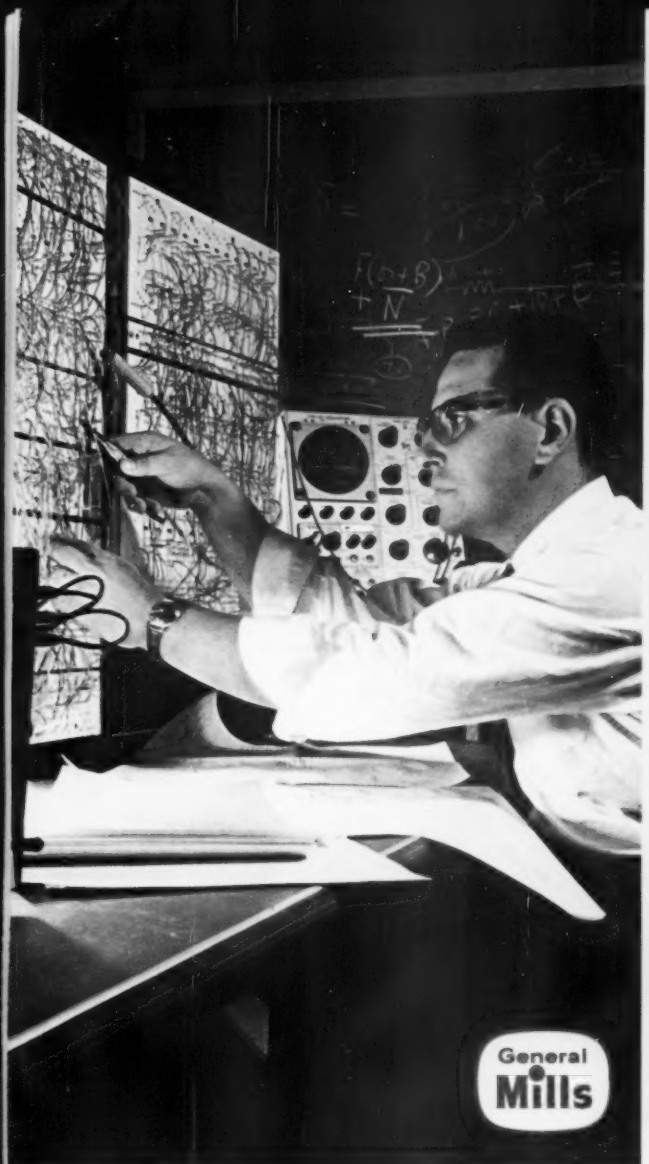

Here is Francis Alterman, Manager of General Mills Digital Computer Laboratory, checking one of our newest computers which he helped design. General Mills computers, both analog and digital, are being used in missile guidance, bombing and navigation systems, automatic surveying and in industrial control. In future space travel, computers will help control navigational systems of space vehicles and will process data gathered in outer space.

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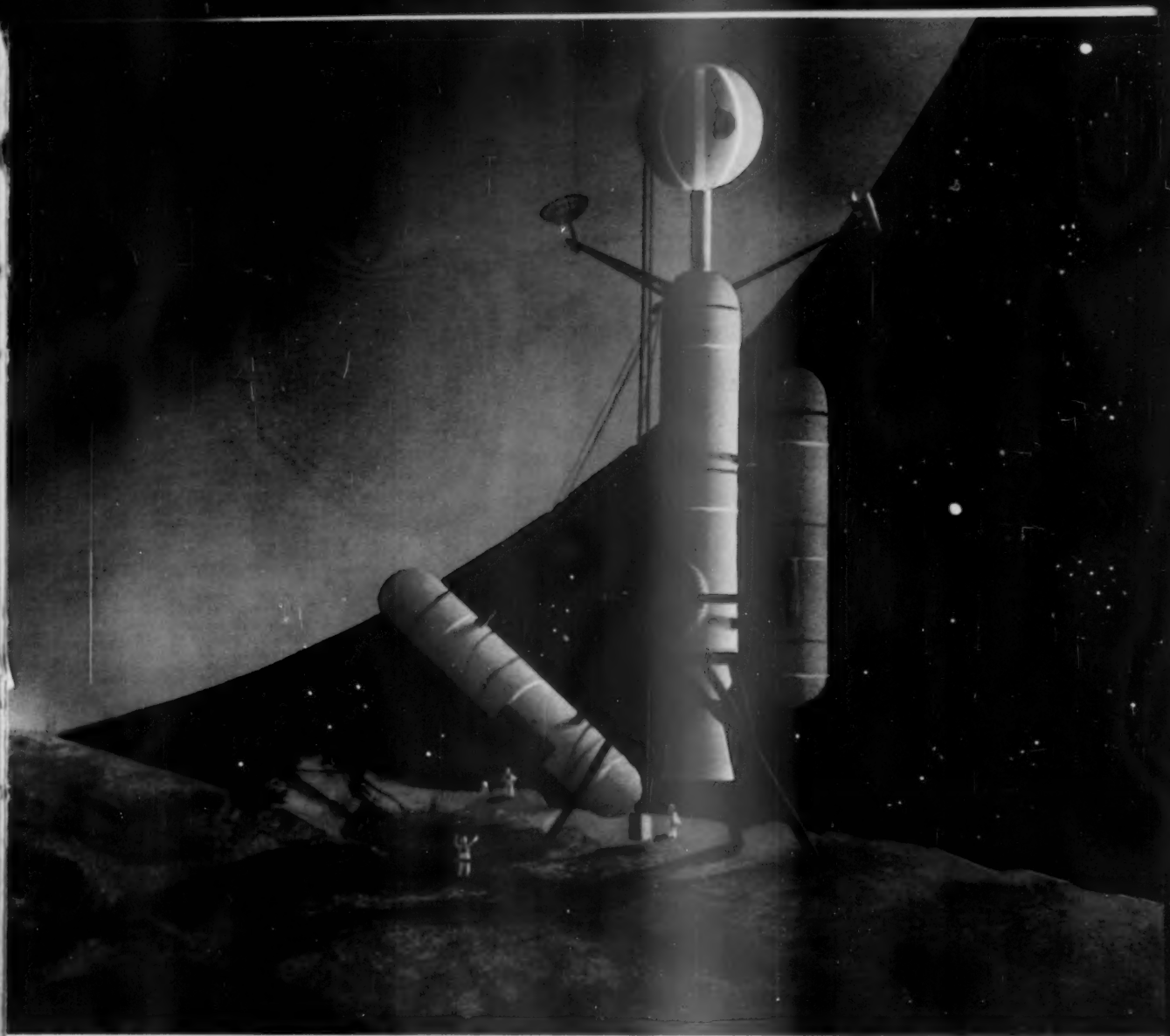
Our research activities cover broad areas in physics, chemistry, mechanics, electronics and mathematics. Some of the studies representative of these activities are: ions in vacuum, deuterium sputtering, dust erosion, magnetic materials, stress measurements, surface friction and phenomena, trajectory data and infrared surveillance.

In our engineering department, current projects include: specialized inflatable vehicles and structures, airborne early warning systems, micro wave radar test equipment,



Mars seen from one of its moons . . . illustration from book written for General Mills by Willy Ley.

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AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command:

Aircraft Instrument Division, R. C. Allen Business Machines, Inc., Grand Rapids, Mich., 595 ea., indicators, turn and slip, 4-min. turn, Type MD-8, in accordance with specifications MIL-I-7805A, dated Feb. 8, 1956, FSN-6003-6610-580-7922, for KC-135A and T-37A aircraft, (PR's EA-0-6610-6038 and EA-0-6610-6039), $68,775.

Westinghouse Electric Corp., Dayton, Ohio, 231 ea., transformer assemblies, contractor's part number A42A9262-2, Aerno 42-0833; 451 ea., a.c. generator control panels, contractor's part number A42A9232-4, Aerno 42-0340; 255 ea., rack assemblies, contractor's part number A42A9130-10, Aerno 42-0724; spare parts, maintenance tools and test equipment and data, for support of KC-135A aircraft, (PR EA-0-6115-6035 and amendments 1 and 2), $430,961.

The General Tire and Rubber Co., Akron, Ohio, 260 ea., wheel assemblies, main 20x4.4, type VII, Aerno 41-1192; 260 ea., brake assemblies for 20x4.4 main wheel, Aerno 41-1194 and data, installations for T-37A aircraft, (PR EA-0-1630-6060), $72,516.

Dalmo Victor Co. Division, Textron, Inc., Belmont, Calif., 1 ea., intercommunication set, AN/GIC, handbooks and data, end use: unknown, (PR 07077), $56,832.

Propeller Division, Curtiss-Wright Corp., Caldwell, N. J., product improvement on Navy propellers, (MIPR R60-2866-17-NOas), $136,839.

Kearfott Co., Inc., Little Falls, N. J., engineering services to support AJN-8 testing (applicable to B-52 aircraft), (PR EG-9-05A-4882), $57,974.

Eclipse-Pioneer Division, Bendix Aviation Corp., Teterboro, N. J., 180 ea., indicators, altitude, vertical speed, type AAU-1/A, Aerno 60-6307; 124 ea., indicators, indicated airspeed, Mach, safe speed, type AVU-1/A, Aerno 60-6306; 80 ea., amplifiers, altitude, vertical speed, Type AAU-1/A, Aerno 60-6322; 82 ea., amplifiers, indicated airspeed, Mach, safe speed, type AVU-1/A, Aerno 60-6321; spare parts, special tools and test equipment and data, for: F-105D aircraft, (PRs EA-0-05C-6610-6017; EA-0-05C-6610-6018; EA-0-05C-6610-6019; EA-0-05C-6610-6020), $2,882,682.

Hughes Products International Airport Station, Hughes Aircraft Co., Los Angeles, Calif., 7 ea., memoscopes, Hughes Products model 104 and manuals, (PR C-003113), $26,136.

Ampex Corp., Redwood City, Calif., 4 ea., magnetic tape recorder-reproducers, Ampex model FR-1107, 2 ea., magnetic tape reproducers only, Ampex model FR-1107 and ancillary equipment, (PR C-003098), $96,219.

Mincom Division, Minnesota Mining & Manufacturing Co., Minneapolis, Minn., 1 ea., magnetic tape recorder-reproducer, instrumentation, Mincom model C-114, (PR C-003112), $27,272.

Small Aircraft Engine Department, General Electric Co., West Lynn, Mass., nonoperational YJ85-GE-5 turbo jet engines for Air Training Command School, (PR EP-9-2804-4816), $31,780.

Pioneer-Central Division, Bendix Aviation Corp., Davenport, Iowa, 114 ea., indicators, indicated airspeed, range 100 to 850 kt., type AVU-^{2}/A, Aerno 60-6303 (for F-105D, F-106A and F-106B aircraft), (PRs EA-0-05C-6610-6043 and amendment No. 1 and SA-9-6610-11296), $28,423.

Industrial Components Division, Raytheon Co., Newton, Mass., 2 ea., Raytheon Rayspan spectrum analyzers, model MRFR-30-2; 1 ea., Raytheon Rayspan spectrum analyzer, model MRFR-30-3, (PR C-003110), $43,325.

Leonard Anderson Associates, Inc., New York, production of a 35 mm. black and white motion picture entitled "Aircraft Accident Investigation," (PR EM-O-MP-6435), $39,707.

Dulles Outlines CIA's Intelligence Role

(Allen W. Dulles, director of the Central Intelligence Agency, recently detailed CIA's role in gathering and assessing information on Soviet military strength and just how, and when, estimates of its potential can be made. Because of the role such estimates play in U. S. military decisions and the current debate over their functions in determining Defense Department budget levels, AVIATION WEEK is reprinting significant extracts from Mr. Dulles' speech made at a meeting of the Institute of the Aeronautical Sciences in New York.)

. . . The experience of World War II taught us something which countries like the United Kingdom and most of the major European powers had learned well before us, namely, that an effective intelligence system is important to national security.

In reaching this same decision in 1947 we did not attempt, and I believe wisely, to create a unitary system. Rather it is a coordinated, integrated system. The Central Intelligence Agency has large responsibilities for coordinating the over-all intelligence effort, but does not supplant the work of other agencies.

In the United States Intelligence Board, over which I have the honor to preside, we bring together the intelligence representatives of the Department of State, the Department of Defense, of the military services, and others who have capabilities in the collection field or in the analysis of intelligence. Included on the Board are representatives of the Federal Bureau of Investigation to aid where domestic intelligence matters have international implications, and of the Atomic Energy Commission with its expertise in the nuclear field. Of course, we draw upon the great knowledge and experience of private organizations such as those which so many of you represent, and we benefit from the wisdom of our scholastic and educational institutions.

Board Functions

The United States Intelligence Board has the responsibility for analyzing all relevant intelligence collected by, or available to, all agencies of government. The resultant product, in the form of coordinated memoranda and estimates, attempts to cover, on a worldwide basis, the developing trends, military, political and economic, which bear upon our national security.

It is our purpose to get our estimates out in time to be of use. Post mortems of lost opportunities are valuable to help us improve for the future; they are of little use in developing a policy for the present.

The responsibility for effecting the coordination of intelligence and issuing the resulting product lies with the Central Intelligence Agency.

The analysis of human behavior, the anticipation of human reactions in a given situation, can never be assigned to a computer machine, and sometimes baffles the cleverest analyst. We have, it is true, drawn up long lists of crises indicators to be checked off in various situations where belligerent or hostile actions are threatened. These lists, based on long experience, are useful but the future is rarely like the past; and we only have some forty years' experience in dealing with international communism of the Moscow variety and 10 years' experience with communism directed from Peiping.

More Soviet Data

Today in the Soviet Union more information is becoming available to the outside world than was the case in the past. This applies particularly to the development of Soviet peacetime economy, their competence in the various peaceful industrial fields, and their problems in trying to apply Marxist theories in agriculture, which has proved to be a costly and unsuccessful undertaking.

Allen Welsh Dulles, director of the Central Intelligence Agency since early 1953, has been intermittently engaged in intelligence work for the past 40 years. Brother of the late Secretary of State John Foster Dulles, Mr. Dulles first entered the foreign service in 1916. He became engaged in intelligence work in Austria-Hungary shortly before the U. S. entered World War I and followed this with tours of Switzerland and, later, the Peace Conference of Versailles in 1919.

Mr. Dulles resigned from government service in 1926 after stations in Vienna, Bern, Berlin, Constantinople and Washington, completed his study for a law degree at George Washington University and joined the New York law firm of Sullivan and Cromwell.

He re-entered government service in 1942, directing the activities of the Office of Strategic Services in Switzerland throughout most of World War II. He returned to his private law practice shortly after the war only to come back to Washington in 1948 for a "six weeks'" tour of duty on the staff of CIA's first director, Gen. Walter Bedell Smith. He has been there ever since.

In the military area, however, the Soviets attempt, even today, to maintain as strict a veil of secrecy as in the old times of Stalin. As an exception, from time to time Mr. Khrushchev himself, as he has done in his own recent "State of the Nation" address, tells us of his plans. Now he proposes to reduce his military manpower, to phase over from the bomber to the guided missile, and largely to abandon surface naval vessels and emphasize the submarine. Of course we have to analyze his statements in order to determine what part is hard fact and what part is said to beguile us.

The Kremlin's security is good, but a great deal is known to intelligence beyond the trickle of military information that is given out officially. In fact, the greater part of what Khrushchev has now told us about this military planning had been anticipated many months ago, and long since our estimates had been revised to take account of the slackening in aircraft production, the change in emphasis in the Navy and the Soviets' vigorous and orderly program in the field of guided missiles.

The proposed reduction in military manpower comes somewhat belatedly as far as the Soviet Union is concerned. We ourselves had done this much earlier. For the Soviet, it is in part a response to the change in emphasis as a result of new weaponry. It is also calculated to help meet the requirements of their industry for more manpower during this period when the Soviet is feeling the effects of the reduced birth rate of the war years.

Soviet Strength

Even after these announced reductions, however, we should not forget that the Soviets would retain a formidable balanced military establishment, in no way wholly dependent on their missile strength.

The stress which Khrushchev has laid on ballistic missiles, or rockets as he prefers to call them, and the resultant discussion in the Congress and in the press about where we stand in the missile race, has recently directed considerable attention to intelligence estimates. There seems to be some confusion about what I might call the methodology in their preparation. I should like to try to set this straight.

First: Our intelligence estimates do not attempt to give a comparative picture or net estimate as to where we stand vis-a-vis the USSR in weaponry. We, in intelligence, are not authorities on American military programs. Naturally our own domestic experience and our knowledge as to the state of the art in this country are useful guides in judging others' capabilities. Our job is to determine where the Soviet Union now stands in the missile and other military fields, and where it is going in the immediate future. We are not in the business of

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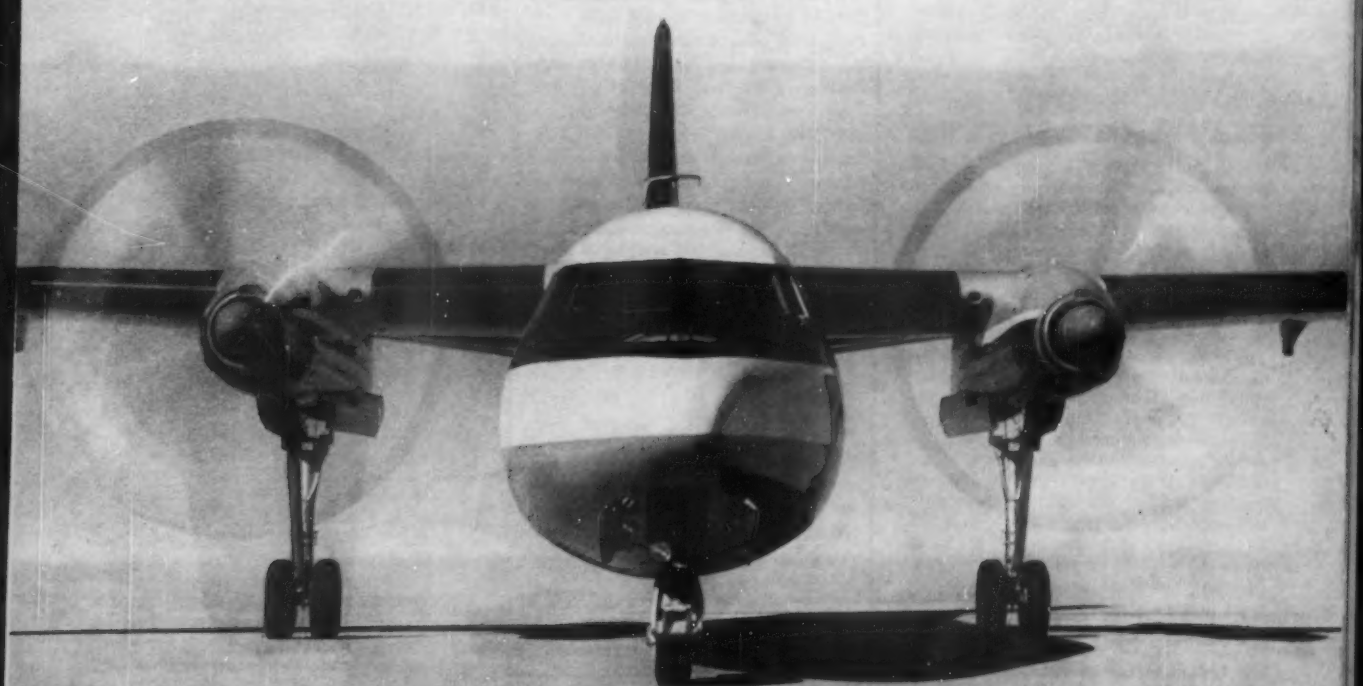

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passing upon whether there is such a thing as a missile gap.

Second: The analysis of any given Soviet weapon system involves a number of judgments. These include, for example: Soviet capability to produce the system; probable Soviet inventories of the weapon system as of today; the role assigned to this system in Soviet military planning; the requirements the Soviet high command may lay down for the weapon over the future. All these judgments are to some degree interdependent. They lead to a calculation of how far and how soon the Soviets are likely to develop the system. Manifestly this kind of estimating is of the highest importance to our own planning.

Basis of Estimates

Third: It is difficult to predict how much emphasis will be given to any particular weapon system until the research and development stage has been completed, tests of effectiveness have been carried out and the factories given the order to proceed with serial production. No group of people knows this better than you do as regards our own military program. Consequently in our estimates we generally stress capabilities in the early stage of Soviet weapons development and then, as more hard facts are available, we estimate their probable programing, sometimes referred to as intentions.

Finally: What I am describing is not a new or novel procedure. Every estimate of this nature regarding military hardware, irrespective of the type of weapon, whether it be a missile, a submarine or an airplane, goes through this general process of analysis in the intelligence community and has done so for many years. First we assess the Soviet capabilities in each of these fields, and then as the evidence accumulates and as a pattern begins to emerge, we reach our estimate as to the likely construction program.

The fact that in the later years of development we can crank into our estimates more of the elements of programing and future intentions than we can at the beginning does not indicate any change in the intelligence approach to the problem. It merely means that our sources of information in one year may permit of a judgment which is always needed by the planner, but one which could not have been properly made earlier.

Soviet Bomber

For example, in 1954 the Soviets began production of a heavy bomber comparable to our B-52. Every indication pointed to their having adopted this plane as a major element of their offensive strength and to an intention to produce these planes more or less as fast as they could. Based on our knowledge of their aircraft manufacturing industry we projected a build-up of this bomber force over the succeeding several years. We were certain that they had the capability to produce the numbers forecast; the available evidence indicated that they had the intention to translate this capability into a program.

But we naturally kept a close watch on the actual events. Production did not rise as rapidly as it could have. Evidence accumulated that the performance of the plane was less than satisfactory. Mean-

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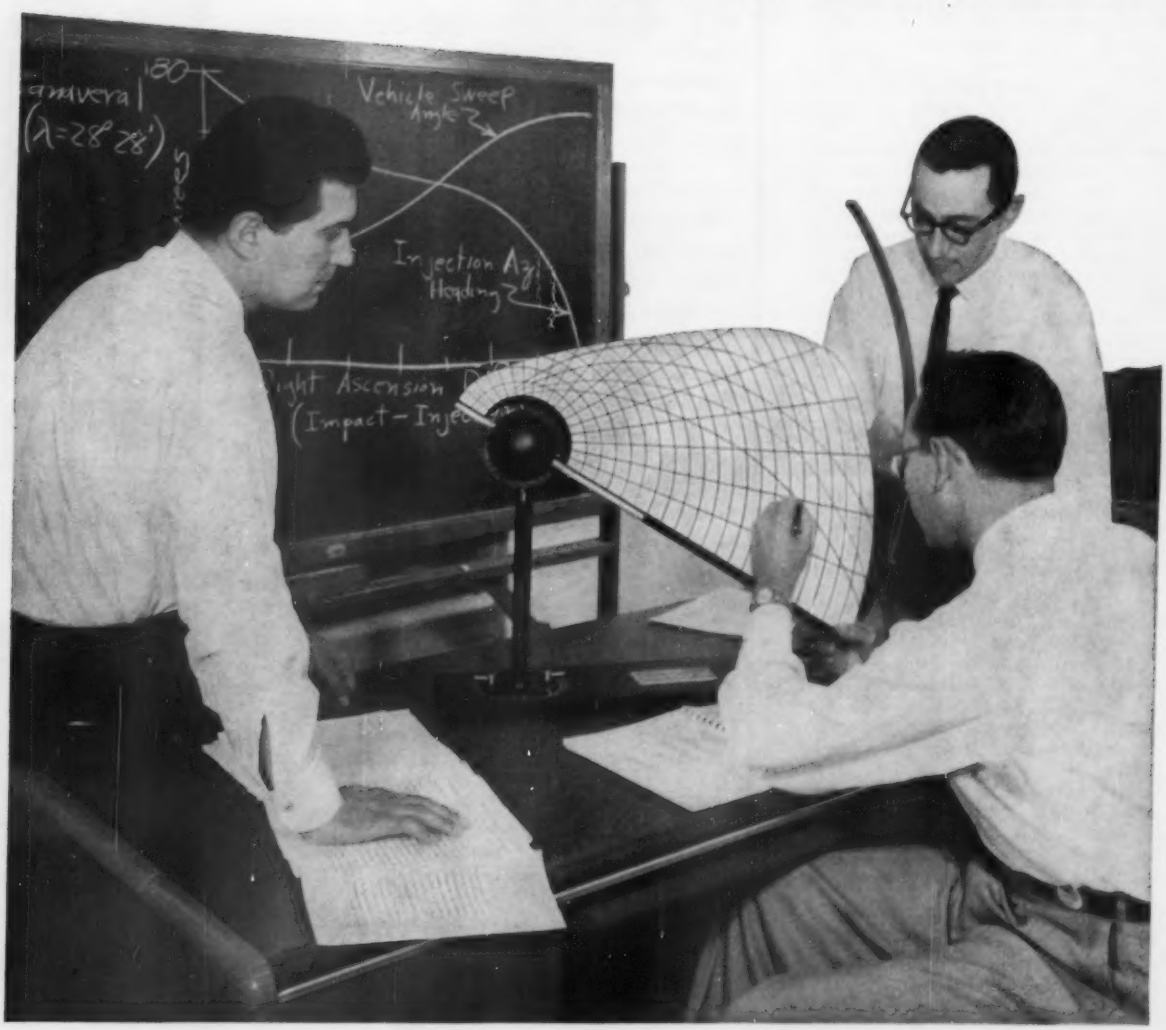


while we noted progress in their missile testing program. At some point about 1957, the Soviet leaders decided that the heavy bomber production should be held down to a minimum. In those days, some people in this country were writing about the coming bomber gap.

As we gained evidence of that change in program, it became incumbent on us to revise our intelligence estimates, and we did so. The capability remained, the policy and hence the intent to go forward with the heavy bomber changed. This Khrushchev himself has now announced in his recent speech. In the field of naval surface forces and conventional submarines, Soviet policy went through a similar cycle in order to prepare for more sophisticated types of submarines. This has recently been alluded to by Khrushchev but was known to the intelligence community for many months.

In citing these examples of cutbacks in the numbers of Soviet bombers and submarines, I do not wish to leave any impression that I think the Soviets will do the same in the long-range missile fields. During this past year they have been carrying on an orderly program of flight-testing their missiles which permits certain conclusions to be drawn. Most recently, presumably for the propaganda effects they hope to gain, and because they were running out of homeland space in which to test, they have advertised where in the Pacific they proposed to target the tests of their space vehicles or "rockets" for the month ending Feb. 15. Thus they flex their muscles in public whereas in the past they have been doing it without publicity. They wish to call attention to the strength of their sinews.

No Underestimation

There is no tendency in the intelligence community to underestimate Soviet sophistication in any phase of the missile field, or the progress they have been making in developing their long-range missile system. We have not downgraded this system this year as contrasted with last year.

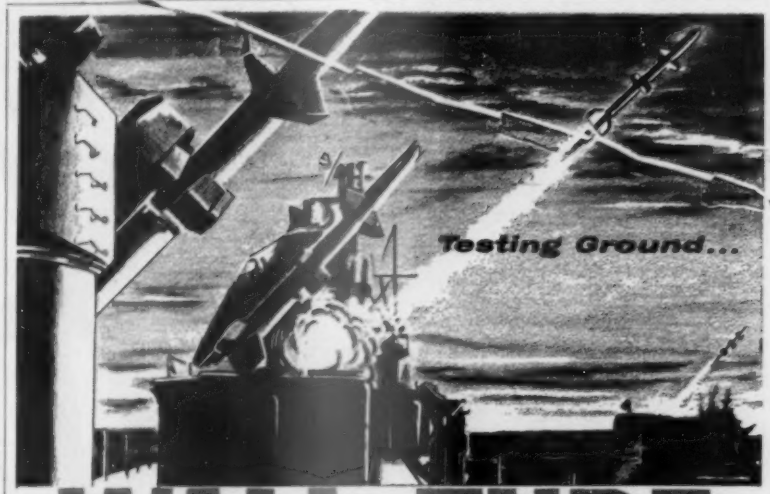
However, it would be just as wrong to let the Soviet talk the world into believing that the ICBM, powerful as it is, constitutes the only armament with which a country should equip itself. I believe that the Soviets are trying to take advantage of the publicity they have achieved with respect to both missile and space programs in order to make the unsophisticated believe that these achievements mean overall superiority in the military field. Such superiority, in the opinion of more qualified experts than I, does not exist.

In viewing problems such as the Soviet strategic attack capabilities with missiles and other weapons, we in the intelligence community are keenly aware of the impact which intelligence estimates may have upon our own military posture and our military programing. I can assure you that in preparing them we look to nothing but the available facts, disregarding all outside considerations, political, budgetary or other. At times we have overestimated. At times we have underestimated. But looking back on the last few years with the benefit of hindsight, the record of estimating is credible. Facts have no politics. We are diligently seeking and interpreting the facts without fear or favor.

As regards the influence of a particular department or service on our estimative process, I recognize the we are all human and have our prejudices and our strong convictions. I can also assure you that we have such a level of responsibility representing a broad cross section of both civilian and military participation on the United States Intelligence Board that there is little opportunity for parochial interests or considerations of any member to influence the final product. But if any member of the Board has a dissenting view of any issue, that member is entitled to express it as part of the estimate so that the policy maker can judge of it as such.

In addition to reaching sound intelligence judgments on the crucial issues of the day, the other major problem of the intelligence officer is to get the reports and estimates before the decision-making echelons of government. In our own government, this means of course that the intelligence goes primarily to the President, the secretary of state, the secretary of defense, and the National Security Council. The latter is, in effect, the President in Council, to which the Central Intelligence Agency is under law primarily responsible. Of course, as we see today, intelligence is also made available to the Congress, as appropriate, to help in the legislative and appropriation processes.

Past history, as I suggested at the outset, is replete with instances where the intelligence was available but the intelligence officer fumbled in the handling of it, as well as instances where the intelli-



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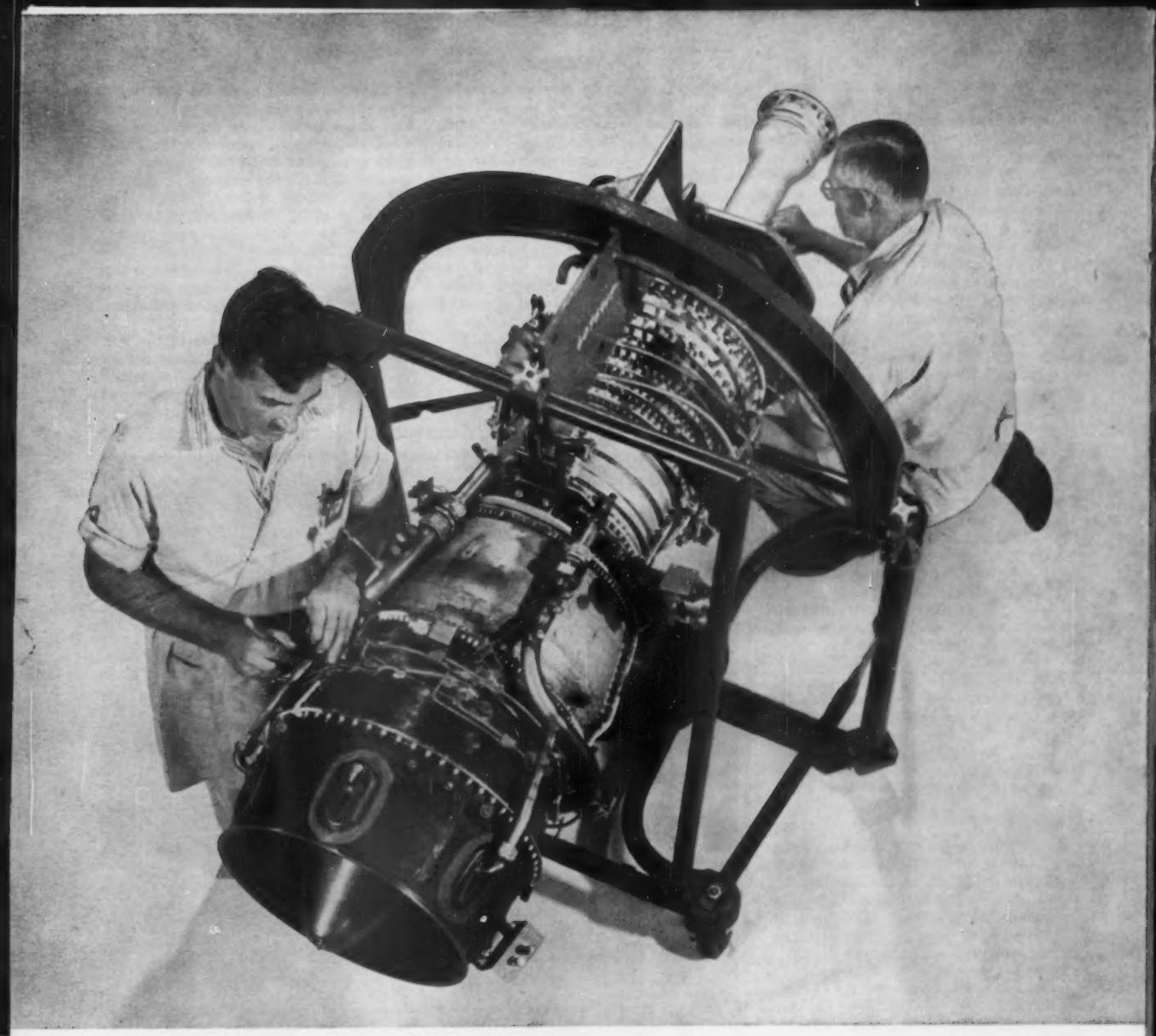
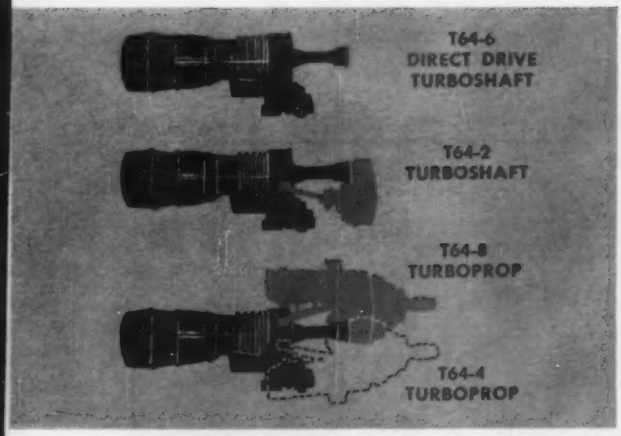
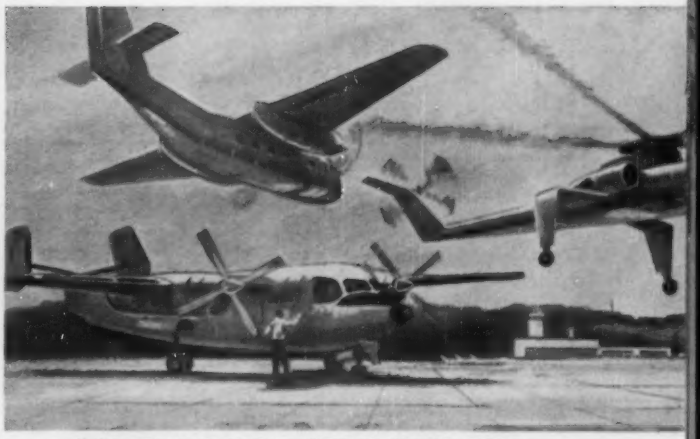




BUILDING-BLOCK DESIGN is a principal feature of the T64 engine. Turboprop configurations are obtained by the simple addition of reduction gearing to the basic turboshaft engine. This means standardization of parts and simplification of logistic support for users.



LOW SFC AND HIGH POWER-TO-WEIGHT RATIO make the General Electric T64 turboshaft and turboprop engines ideal powerplants for many military and commercial aircraft including STOLs, helicopters, skycranes and other VTOLs. These are illustrated above in a composite artist's drawing.

FROM GENERAL ELECTRIC...

PIONEER AND LEADER IN SMALL AIRCRAFT GAS TURBINE PROGRESS

T64 turboshaft/turboprop: 2600 hp-class engines for tactical and support aircraft will be flight qualified and available this year

Airframe manufacturers and military and commercial aircraft users requiring economy of operation and high performance, will find these features in General Electric's T64 gas turbine powerplants.

OUTSTANDING PERFORMANCE

Turboshaft T64: 2650 SHP—0.506 SFC—713 lbs
Turboprop T64: 2570 ESHP—0.522 ESFC—1079 lbs

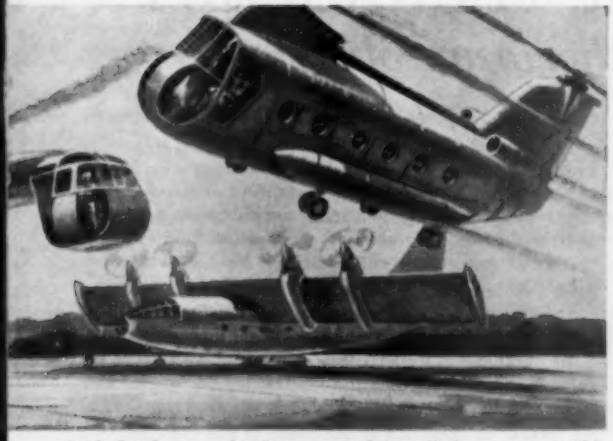
. . . and the same basic power unit, including controls, is common to all T64 configurations. Superior missions, including greater payload, speed, range and economy for support and tactical aircraft can be obtained by utilizing the low specific fuel consumption and attractive power-to-weight ratio of the T64.

INSTALLATION FLEXIBILITY—With designed-in ability to operate continuously at attitudes from 100° above horizontal to 45° below, the T64 engines are ideal powerplants for VTOL and STOL aircraft. Featuring compact engine size, split casings and grouped accessories, the T64 is designed for easy installation and maintenance.

EARLY AVAILABILITY—The T64 engine development program has been on schedule since its inception. The first official test runs of both the turboshaft and turboprop engines were completed ahead of schedule in early 1959 and the rapid pace is continuing. From the user's standpoint, this T64 development progress means that flight qualified engines are scheduled for availability in 1960.

FOR MORE INFORMATION—Brochures are available that describe the T64 engine in detail. If you would like this information, write Section 233-31, General Electric Co., Schenectady, New York.

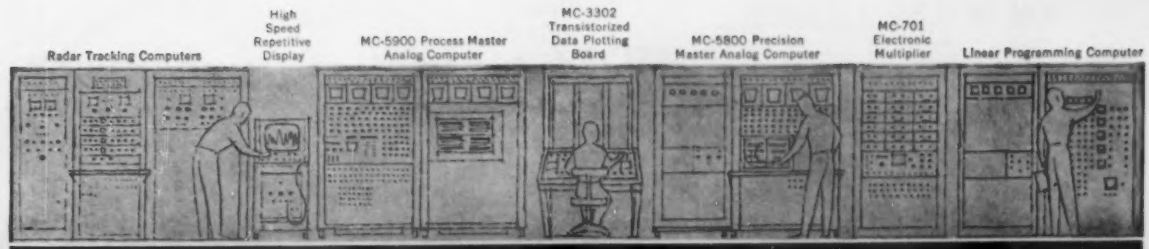
T64 RELIABILITY will go hand in hand with outstanding performance. A unique government contract which calls for 10,000 hours of engine running by the time all configurations of the engine are qualified will help assure both reliability and performance for the T64 engine.



Both fuselage and wing-mounted installations are possible with the various configurations of General Electric's T64 engine. This flexibility plus T64 high performance can provide important benefits to aircraft manufacturers and users.

GENERAL ELECTRIC

General Electric's Small Aircraft Engine Department also produces the T58 and CT58 turboshaft engines for military and commercial helicopters, the J85 turbojet engine for aircraft, missiles and drones and is presently developing the new CF700-1 turbofan engine for medium and light weight aircraft. These engines are a part of G.E.'s growing flight power spectrum with over 25 million hours of accumulated flying time.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DYSTAC (Dynamic Storage Analog Computer) synthesizes the advantages of both analog and digital computers. DYSTAC combines the analog's speed, lower cost, ease of programming, and improved output data presentation with the digital computer's unique capacity for data storage and time sharing of computer elements. With DYSTAC you can now solve the most complex problems, ranging from distillation column design to multi-dimensional heat transfer... from boundary value problems to transport lags.

In distillation column design, for example, DYSTAC employs only 44 amplifiers on a four-component problem; the number of amplifiers required is independent of the number of plates. With any other analog computer each plate must be reproduced in the circuitry—for a 30-plate column, over 1200 amplifiers are needed unless manual reprogramming is employed. What's more, only DYSTAC yields a plate-by-plate display of all column conditions.

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Marine Corps Evaluates Gyrodyne YRON-1

Marine Corps is conducting tactical evaluation of the Gyrodyne YRON-1 helicopter at Quantico, Va. Vehicle is being considered for combat use in reconnaissance, courier, observation and limited logistic support operations. Payload is 250 lb. maximum.

gence was properly reported but not heeded.

At various times over the past 40 years, I have served in one capacity or another under every president of the United States, beginning with Woodrow Wilson, and generally in some capacity related to intelligence.

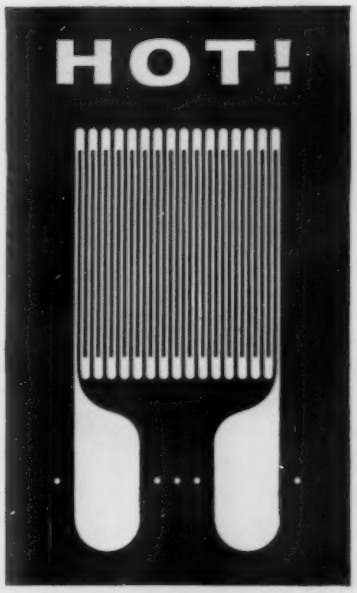
One of the great and continuing advantages we have enjoyed over our history is that we have been led by men who have come to their high positions deeply imbued with the democratic processes. As a part of this, our leaders have generally made themselves readily accessible to information from their subordinates and their intelligence officers. This feature of accessibility has been maintained by our presidents despite the fact that the burdens on the executive have been multiplying astronomically, and the complexity of the problems before them, particularly in the field of our foreign relations, has been augmenting in geometric ratio. At the same time, the period within which decisions have to be made has been steadily decreasing.

During the last 10 years that I have been in Washington, I have served under two presidents of differing political parties. There never has been a time when the Director of Central Intelligence has not been able to get to the President in a matter of minutes on any issue that he considered of immediate importance.

Nor is this access limited to crises situations. On a daily basis, we in the intelligence community have an opportunity to lay before the President and the leading officials of the Department of State, the Department of Defense, and the National Security Council our appraisals of unfolding events of policy significance. This is supplemented by weekly oral briefing which I give to the National Security Council, covering important current events or dealing with the intelligence background of policy decisions that may be before the Council. Issues in our foreign relations these days do not always wait for the painstaking preparation of elaborate staff papers.

We have no reason to complain that we lack adequate opportunity to market our product. We have every incentive to see to it that our product contributes to our national security.

Those who work on intelligence, are sometimes viewed as Prophets of Gloom. Personally, I am an optimist but also, I trust, a realist, as are my associates in the intelligence community. Sometimes we do



New Tatnall MetalFilm 102 higher-temperature backed strain gages from Budd

- Operating range to over 400°F surpasses previous strain gages by at least 50°F in all applications.
- Precision-designed and constructed for exceptional accuracy, repeatability and ruggedness.
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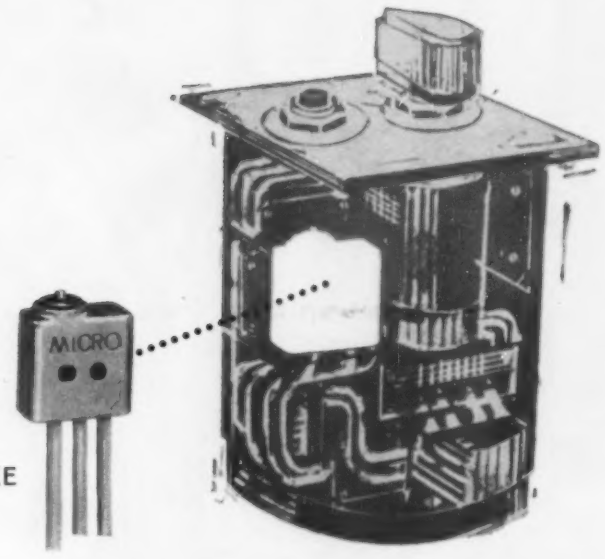

New Sub-subminiature XE

SMALLEST Environment-Sealed Switch Ever Designed

New design ideas in compact aircraft and missile devices get more "thinking room" from the MICRO SWITCH "XE", 30% smaller and 20% lighter than any previous environment-sealed snap-action switch. The precision switching unit is sealed with an elastomer seal bonded to the pin plunger and the metal housing. It is embedded in epoxy resin within a corrosion resistant, treated aluminum housing. Operation is dependable in a temperature range from −65° to 230°F, with no sacrifice in electrical capacity or precise mechanical performance.

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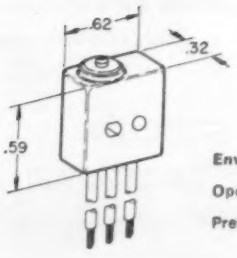

Environment-Sealed "XE"

Operating Force	5-17 oz.
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ELECTRICAL RATING: 28 vdc: 7 amps., resistive; 4 amps., inductive (sea level); 2.5 amps., inductive (50,000 ft.); 24 amps., max. inrush.

have to be the harbingers of ill tidings because it is our duty to report on activities in other lands which might detrimentally affect our own national security.

Today we have on the world scene the Soviet Union, Communist China and the Communist bloc with their dynamic industrial, economic and military programs, spearheading and directing Communist parties, Communist intrigues, and Communist subversion on a worldwide basis. We must recognize that we face stern and relentless competition.

It is Khrushchev's present expressed intention that this should be competition short of all-out war, but whatever may be our views of his intentions, certainly no other "holds" will be barred. When he speaks of coexistence, it is the type of coexistence that will leave the Soviet free to press forward on its mission to communize the world.

Today in the free world, we have a great lead in our industrial and economic strength. It is more than twice that of the Soviet Union, and if we include our allies in the free world, while adding to the Soviet the present potential of Communist China and the satellites, the lead of the free world is still greater.

On the other hand, the peoples in the Communist nations are being driven to work harder to make their Communist system a universal one, than we are working to assure ourselves that these aggressive and subversive aims are defeated.

So far the Soviets have shown great ability to channel their growing resources into fields which build up their national power, including their military might. Their leaders have succeeded in persuading their people to be content with a much smaller share than we of consumers' goods and of what we consider the essentials to a well-rounded life, so that they, the Soviets, can build up their heavy industry, turn out military hardware and have plenty left over to support international communism. We believe that the value of their total annual military outlay approximately equals our own. There is no cause, therefore, for us to view the future with any easy complacency. . . .

British Rail Commission Bids for Stake in Airline

London—British Transport Commission, which runs British Railways, is negotiating for a stake in Silver City Airways, which operates car ferry services between Britain and Europe.

The British Transport Commission constitution does not allow the operation of air services, but a minority holding in an airline company is within its statutory powers. Silver City share capital is held 70% by P & O Shipping Lines, 20% by Eagle Star Shipping Line, and 10% by the government-owned Cable and Wireless, Ltd.

Transfer of the Cable and Wireless interest could be the way in for the transport commission.

Silver City has stated its need for improved rail links with its air services from Manston Airport, near Ramsgate.

Here is a man you should know
he's a DELAVAN FUEL INJECTOR SPECIALIST

His name is Roger W. Tate. He did his doctoral research in the field of pressure atomization at the University of Wisconsin, has taught reaction kinetics, and worked on process improvements for petroleum refining.

Dr. Tate is Director of Research at Delavan. He has developed many atomizing devices and uniquely accurate test equipment for Delavan. He is widely known for his research on spray analysis and fuel injection.

Specialized talent like Dr. Tate's is the main reason for Delavan's leadership in fuel injection. If fluid metering and atomization are part of your product, take advantage of Delavan's specialized experience and ability to deliver aircraft quality. Send specifications to the address below for free recommendations.

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Mooney Predicts Higher 1960 Volume

By Erwin J. Bulban

Kerrville, Tex.—Dollar volume of some $3.3 million in business aircraft sales during 1960, compared with approximately $2.8 million last year, was predicted for Mooney Aircraft, Inc., by President Hal Rachal during the distributors and dealers annual meeting to usher in the company's new models.

With some 600 four-place Mooney Mark 20s out in the field, the feeling here is that the company is now well past that critical period where lack of public exposure hampers its growth rate—indications all point to higher growth rates than have been possible in the past. The production rate, although higher this year (anticipated are 225 units) compared with last year's 211 units, is being held back some by introduction on the line sometime in August of the new 250-hp. Mark 21, a higher-powered version of the 180-hp. Mark 20A.

As recently as 1957 Mooney delivered 93 units at a dollar volume of $1,045,000, which provides some gage as to the company's growth.

Current output of Mark 20As is one complete aircraft every 12 working hours. This will increase to one unit every eight hours in May, which will be retained until August when a split schedule is developed with the Mark 21 phasing in with Mark 20A production.

Prominent guidepost to the direction Mooney will be striving for is its recent acquisition of Ralph Harmon as chief engineer and vice president-engineering. Harmon has a long background in business aircraft development programs, including top design responsibilities in the past with Beech on the Bonanza, Twin-Bonanza and Mentor, among others, and with Cessna, where he had cognizance over the four-engine pressurized Model 620 and then with McDonnell, where he worked on the four-jet Model 119.

Harmon's appointment indicates that Mooney is planning to round out its airplane line and also possess a capability for advanced projects. Rachal told the dealers ". . . don't be surprised if in 1970 you see Mooney with a six-place turbofan business airplane that cruises at 600 mph." This doesn't mean that the company has such a plane on the drawing boards, or that Harmon will start sketching one immediately, but it does point up management thinking on company plans to move up out of its current position.

Rachal said that he thinks Mooney should strive to be one of the Big Three in the industry in the future—a line-up now that now includes Beech, Cessna and Piper. Increasing acceptance of the Mark 20A in Latin America, he says, will probably result in the airplane becoming Number 1 there before it achieves such status in the U. S.

Rachal struck out at Federal Aviation Agency's stand on Airworthiness Directives, which he said were of serious concern throughout the industry. Ever since CAA became FAA, he claimed, the "A-D Club" in Washington seems to have taken pride in hitting the aircraft manufacturers with directives—some justified, some not. If a manufacturer comes up with a product improvement on his own, very often he is hit with an Airworthiness Directive note, requiring mandatory installation, even though the part in question has been satisfactory, Rachal contended.

This policy he noted, has been of considerable concern to companies because of the effect upon the customer, especially those who may just have taken delivery on a new airplane only to be faced with a mandatory and costly change.

To answer this situation, Rachal announced that effective during the meeting, Mooney will pick up the bill for all future Airworthiness Directives that are issued on all Mark 20 series aircraft, from the initial production models which first came off the line in 1955. In carrying out this major policy decision, the company is setting up these guidelines:

- **Mooney will designate** the repair stations where the work is to be done. The stations will be chosen on a basis of assuring that they are qualified and located conveniently to the customer.
- **Compliance with the A-D** must be accomplished within 60 days of issuance of the note to ensure that the work is done promptly and also to permit the company to keep orderly books on each operation. After the 60-day period, the owner will have to pay for the change.

Special insurance plan, developed by Don Flower Associates, Inc., Wichita, Kan., in cooperation with the factory, will provide owners of new Mooney Mark 20As a hull rate of 4%, which the company says is better than any existing coverage except for class of

Bell 47G-2 Fitted for Missouri Rescue Work

New Bell 47G-2 helicopter, which sells for $40,500 (AW Jan. 11, p. 32), has been fitted with litter racks for Missouri State Highway Patrol by Mississippi Valley Helicopters, Inc., St. Louis passenger and charter firm which maintains the aircraft for the patrol and for Illinois Conservation Commission. Mississippi Valley has a Bell 47J-2 Ranger on order.

Materials Memo

News of material for the aerospace industry—
from the 27,000 products of the 3M Company

■ POT OR NOT—That's the question

Are you holding off on potting of critical electronic components because you haven't found a potting resin that'll take the vibration and the high temperature in your system? Don't write off the many advantages of potting before looking into "Scotchcast" XR-5017, a silicone rubber foam system developed by our ELECTRICAL PRODUCTS DIVISION.

"Scotchcast's" ability to absorb vibration is due to its resilient but tough closed cell structure. These closed cells also assure you of maximum moisture resistance. (Water absorption after exposure for 24 hours at 90% RH is negligible.) As we've already implied, this material is no slouch in the high temperature regions, either. It comes through with flying colors after extended exposure to 500° F. It's equally serviceable as low as −100° F. You'll find that there is no problem in getting adhesion to metals, glass, and most plastic surfaces. The photo shows how the tough foam ruptures before bond is broken. You'll be pleased to know, too, that it's a room temperature curing system—no tricky high temperature curing precautions to observe. Nevertheless, it has an ample pot life of 30 minutes to permit pouring and foaming in place.

Perhaps by now you've begun thinking that this material might work equally well in sealing or caulking applications. We (and a number of others as well) feel that way, too. Let our Electrical Products Division representative tell you more of its exciting properties.

■ FOR REALLY HOT COPY

Here's a material that the devil himself might use for publication of the *Hades Herald*. This new document and thermal insulation paper called "Crystal M" is completely inorganic and is fire resistant. Made from a special type of synthetic mica, these papers have maximum useful temperatures of almost 2000°. Valuable records printed on Crystal M paper have survived the "trial by fire" without loss of the written message.

Crystal M is an insulation that can perform with both versatility and efficiency when the heat's really on. Depending on the nature of the application and the temperature involved, the thermal K may be 0.3–1.5 Btu/hr. x sq. ft. x °F./inch. What's more, its infrared transmission is less than 3% in the region of 0 to 15 microns for a 7 mil sheet. It can easily be applied as a laminate to the surface to be protected. In this form, it offers the added dividend of acting as a fire barrier, as well as thermal insulation. Crystal M also lends itself to lamination to metal foils or can be vapor coated with metal. Such structures find ready application as light weight fire resistant blankets and drapes, or high temperature tapes. Some enterprising designers are considering it as a honeycomb material for fire resistant heat insulative curtain walls.

The paper either as a 100% synthetic mica composition or containing additional reinforcing fibers may be produced in calipers from 2 to 10 mils. Only papers 5 mils thick are now available for sampling. Density of the paper can vary from 0.6 to 1.7.

Other forms of Crystal M which are not yet available for sampling are light weight blocks (10 to 20 pound per cubic foot), binder free compression molded shapes and finally divided powders.

■ FOR A QUICK PICK UP . . .

Dust can become quite a problem—especially around precision instruments and electronic equipment. Now a new, nonwoven, scratch-free fabric—"SCOTCH" Brand Dusting Fabric No. 550—has been introduced by 3M's INDUSTRIAL TRADES TAPE DIVISION to help solve that problem.

This exceptionally thin material consists of thousands of dust-collecting pockets that

pick up and hold the dust. The fabric is formed by extra-long rayon fibres, bound together with a synthetic, odorless, unifying resin. And, since it isn't woven, there are no loose fibers or edges to unravel. Nor is the fabric oily or sticky—it has no silicones or corrosive chemicals which could remain as filmy residue on the dusted surface.

The dusters come in a 30-yard roll, perforated to make 12" x 18" dusters. For more information contact your 3M Industrial Trades Tape Division salesman—or use the coupon below.

■ ABOUT "MIL"

3M's Missile Industry Liaison is a service staffed by technical personnel experienced in rocket propulsion and other phases of space technology. Their job is to translate problems of the aerospace industry to those 3M specialists best qualified to solve them. If you have questions on any of the items mentioned here, or would like to know what else 3M makes—or could make—for your needs, mail coupon.

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airplanes exceeding $20,000 in value. Particularly noteworthy is a feature that will provide the Mooney owner with a 10% rebate on his rate if he completes a full year of operation without claims.

Also, in adjusting damage claims, the insurer will maintain the right to have the factory repair the airplane with the insurer buying parts from the factory and requiring that the customer pick up the airplane at the plant. This system, Flower claims, will be better than requiring that the customer put the job out for bids and perhaps resulting in a less than completely satisfactory repair job. According to Flower, the insurance company will pay charges of transporting damaged aircraft to the factory.

Flower emphasized that success of this plan depended upon the dealers signing up only those people who they feel will be good risks and ensuring that they get a thorough checkout in the new airplane. He also told dealers that it would be in their best interests to keep track of their customer's habits and if someone was taking chances to report him to the insurance company.

Plan currently covers only owners operating their airplanes in the U.S., but the company is working on a special arrangement for extending the system outside this country. Such extension would carry with it a higher rate than the domestic market.

Rachal told AVIATION WEEK that current expansion programs planned for this year include a new final assembly building for the Mark 21 of approximately 50-ft. x 300-ft. dimension. Also, the company will attempt to increase its sales organization by approximately 10 new distributors and 20 to 30 new dealers this year, while at the same time it expects that dealers will increase their sales personnel by more than 25%.

The 1960 Mark 20A shows refinements in detail rather than any major changes. Basic airplane, which lists at the factory for $15,450, now has red-and-green landing gear indicator lights, flush fuel sump drains under the wings to lessen possibility of fire in event of wheels-up landing, improved soundproofing including installation of one-half to one-inch Fiberglas and one-quarter-inch thick windshield.

Tinted windshield is standard equipment on this year's model. Optional equipment offered with the 1960 Mark 20A includes either a two-axis transistorized Mitchell autopilot at $2,440 extra, or a single-axis Mitchell unit at $950, both with heading lock, or a two-axis pneumatic Clarkson unit, without heading lock, for $720.

FACTS the aviation industry should have on commercial uranium

Uranium has many interesting properties.

For example, Davison Uranium has exceptional density — 68% *greater than lead* and about equal to gold. This indicates usages as counterweights in aircraft, shipbuilding, tool making industries — wherever high weight and low volume are factors. It alloys readily with many metals including aluminum, chromium, copper, iron, manganese, molybdenum, niobium, nickel, silicon and zirconium. Corrosion resistance is increased when uranium is alloyed with one of these metals. Davison Uranium possesses high tensile strength and low thermal expansion. While fairly hard (Brinnell 240) at room temperature, uranium becomes very malleable as temperature rises. At 1100°F. its hardness drops to about 20.

Is Davison Uranium easy to fabricate?

Davison Uranium may be melted and cast into any desired shape. It may be formed by extrusion, drawing, rolling, swaging, pressing or forging.

You can machine Commercial Uranium with conventional carbide-tipped machine tools, bearing in mind that it has work-hardening characteristics similar to those of stainless steel.

How about welding?

Success in welding Davison Uranium has been achieved using the Heliarc and shielded arc-consumable electrode process. At this date experiments continue in joining uranium to uranium by brazing or soldering.

How has Commercial Uranium been used?

Present applications in the Aviation Industry are counterweights and static balances. Application in other industries includes shielding materials, telatherapeutic heads, isotope containers. And for many years, uranium has been used as color agents and glazes.

Is Davison Uranium safe?

Radiation hazards are minor. AEC tests indicate a *week's exposure* to depleted uranium is only about *1/10th to 1/100th* the radiation received from an *ordinary chest X-ray.*

Must special storage precautions be taken?

Uranium metal (except fines) can be *handled and stored with methods similar to those used with any other massive metal.* Fines, however, are flammable and should be stored under oil or water.

Is Commercial Uranium expensive?

Not at all. For example, in lots of 1400 pounds or more Commercial Uranium is priced at just $4.60 per pound — considerably cheaper than other heavy metals, with the advantage of superior density.

Need more information?

A letter will bring you additional details for the application of Commercial Uranium to your products or processes. Write today to Department D109, Erwin, Tennessee.

do!

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U.S. Glider Team to Compete at Cologne

By Russell Hawkes

Los Angeles, Calif.—Fund-raising campaign is under way to send a team of top U. S. sailplane pilots to the 1960 World Gliding Championships at Cologne, Germany, this June, according to Lloyd Licher, executive secretary of the Soaring Society of America.

Like other international competitions, the championships can be expected to generate cold war overtones. U. S. entries in international sports contests receive no regular government support and, because of this, sometimes lose points in subsequent propaganda contests.

American pilots in the 1958 World Gliding Championships were obliged to rent European aircraft since they could not afford transportation for U. S.-designed sailplanes. Licher said the society has high hopes of obtaining government assistance in transporting U. S. aircraft this year.

About 200 companies, most of them in aviation, will be solicited by direct mail in the forthcoming fund drive. Society officials hope to raise $12,500 to pay the expenses of the U. S. team. A similar drive for the 1958 contest raised only $7,503 and expenses totaled $9,687.

The difference came out of the pockets of team members.

Two of the three sailplanes which the U. S. expects to enter in the Federation Aeronautique Internationale-sanctioned contest are being designed and built by their pilots, Richard H. Johnson and Richard E. Schreder. Acting as consultant to both was Dr. August Raspet (AW Nov. 30, 1959, p. 59) of Mississippi State University, a top U. S. expert in low speed aerodynamics.

Five-Time Winner

Johnson, five-time national soaring champion and holder of the world distance record for gliders at 535 mi., now is beginning first flights in his new two-place, T-tail Adastra. Schreder, holder of all three officially recorded world speed records for gliders (100, 200 and 300 km. closed course), began construction of his HP-9 only in December, 1959.

He hopes to parallel his capture of the 1958 National Championship in his HP-8 six months after the beginning of construction. Third U. S. pilot will be Paul Bikle, chief of the National Aeronautics and Space Administration High Speed Test Station at Edwards AFB, Calif. Bikle expects to fly a Schweizer 1-23H in the Standard Class competition.

Aircraft in the Standard Class must be built to a restrictive formula specified by FAI.

A political subject for speculation is whether or not an East German team will be entered in a contest held in West Germany. Political issues were involved in Switzerland's boycott of the 1958 World Gliding Championships at Leszno, Poland.

Red China is another Communist question mark. Poland is known to be providing technical assistance in a campaign to promote a soaring program there.

A national soaring program could be very useful in Communist China as it is the historic method of providing a cheap training system from which to draw professional pilot candidates.

However, U. S. observers doubt that the campaign has progressed enough to turn out pilots of international competition caliber.

U. S. Honors

A U.S. pilot has won the world championship only once. Meteorological researcher, Dr. Paul B. MacCready, Jr., of Pasadena, Calif., was world champion in 1956. In 1958, the most successful American pilot was Lyle Maxey of Downey, Calif., who placed ninth in a field of 37, flying a German Zugvogel II.

Soaring society officials feel strongly about competing in American aircraft. In a report upon the 1958 championships, they said, "In 1960 we hope to be able to fly American sailplanes in the competitions. We feel that this is important for two reasons:

- "**Our pilots** will have much more chance of success.
- "**It is a point of National pride** to be able to show to the rest of the world the type and quality of sailplanes being built in America. We have already established a reputation as a leader in the construction of high-performance, all-metal sailplanes."

Team Members

Captain of the U.S. team this year will be Paul A. Schweizer, vice president of Schweizer Aircraft Corp. Meteorologist will be Bernard L. Wiggin of the U. S. Weather Bureau. Wiggin has been official meteorologist for 13 national soaring competitions held at Elmira, N. Y., and was the U. S. team meteorologist in three previous world championships.

Most U. S. team members are salaried employes and will be obliged to use their vacation time to attend the contest.

It is planned that each American pilot will be allowed a three-man ground crew. German Aero Club, host to the contest, has not announced whether the meteorologist, a spare pilot and an assistant captain will be allowed

Atlanta Helicopter Airways Buys Bell 47J

Atlanta (Georgia) Helicopter Airways, Inc., began scheduled helicopter passenger service at the beginning of this month when the company took delivery of a Bell Model 47J Ranger at Bell Helicopter Corp.'s plant at Ft. Worth, Tex.

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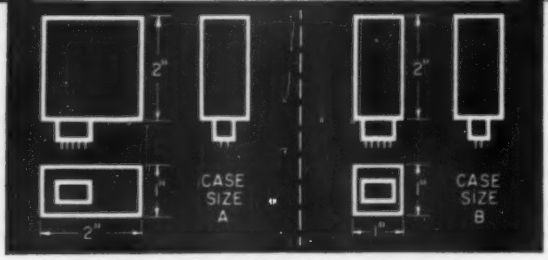

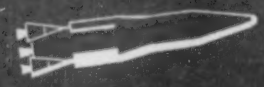

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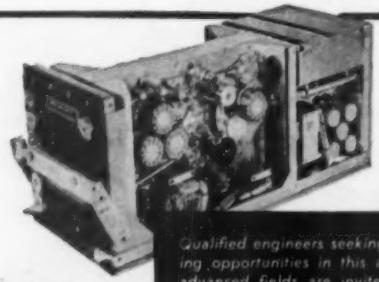

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Cessna 310D Features Lounge Installation

One of five seating arrangements available on the Cessna 310D twin engine business aircraft (AW Dec. 28, p. 24) is shown above, featuring a lounge installation along the left fuselage wall. Armrests are standard equipment on all single seat installations.

as extra team members or must be part of the quota of crewmen. Because of this uncertainty, the assistant captain and spare pilot have not yet been appointed. Depending on German Aero Club's decision, the U. S. team will number from 13 to 16. German Aero Club will probably allow a maximum of 70 gliders to be entered.

Canadian glider pilots have even more trouble financing an entry. They, too, receive no government support and there are fewer large firms able to contribute money. According to present plans, they will rent aircraft and team members will go to Cologne on an excursion flight organized by the Soaring Society. The excursion was planned mainly for non-competing spectators from the U. S., so Canadian pilots will arrive too late to fly on the practice days. This should be a considerable handicap, since they will be flying in strange aircraft.

Practice period will extend from May 29 to June 3. The contest will start June 4 and last through June 17. The two days following the close of competition will be used for the award of prizes and closing ceremonies.

Official contest control radio frequency will be 122.5 mc. Ground control transmitter will broadcast in English, French and German. Power of airborne transmitters is to be limited to 5 watts.

Other frequencies will be allocated for team communications.

World Gliding Championships have never been held in the U. S. European pilots are eager to compete in this country because of the excellent soaring weather conditions which have brought so many world records to the U. S. However, the consensus of Soaring Society officials is that it would be impossible to host such a contest without full government support. A few suggest that some middle-western Air Force base would be the ideal location for such a contest. More records are set in the interior valleys and mountains of California, but smog fronts occasionally push through the mountain passes bringing stable air in which soaring is impossible.

This year's championships are the last biennial contests. In the future, they will be held on a triennial basis. If the 1963 contest is to be held in the U. S., it will be necessary to apply to FAI about two years in advance.

Three of the top five aircraft in the 1958 open competition were from communist countries; the Czech Demant, Yugoslav Meteor and Polish Jaskolka Z. For this year's championships, Schreder has designed his HP-9 especially for light German thermals.

Johnson's Adastra uses an Eppler airfoil section brought to this country from Germany by Dr. Raspet. It is used in the German Phoenix high performance sailplane. Aspect ratio of the Adastra is 21.3 and gross weight with two pilots is 980 lb. When flown solo, gross weight is 790 lb. and wing loading is 4.8 psf. It can be flown solo to get the best sink rate in light thermals or dual to get the best glide ratio. Best sink rate is calculated at 1.65 fps. and maximum lift/drag ratio at 44.5.

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P56	.568	8.1	7000	16.5	.281	10000	23.9	.194	4.66	6.00
P16	.163	3.5	12000	8.0	.250	16000	10.8	.185	3.50	4.75
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Many air carriers, striving to answer perplexing questions presented by a growing air cargo industry, are facing a basic decision: should they convert outmoded piston engine passenger equipment and put it on to air cargo routes? Should they order proposed cargo jets with 100,000 lb. payloads? Should they wait for further turbo-fan evaluation before making their air cargo plane commitments?

Canadair's Forty Four, offers a simple, practical answer to these vital questions. It is an optimum-size, all-new, all-cargo turbo-prop airplane that, in terms of productivity, is vastly superior to converted piston engine equipment, and one that offers, in comparison with the big jets, a payload capacity that is not unrealistically high for profitable operations during the 1960's. Furthermore, the Forty Four suffers little or no operating penalties due to runway limitations, and there will be no community noise problems.

The Canadair Forty Four has a productivity two to three times that of converted piston aircraft, at the same cost per airplane mile, and has a profit potential that will quickly recover any losses on disposal of piston engine aircraft now being used or contemplated for cargo usage. On the other hand, the Forty Four with a payload capacity of 65,000 lbs. and low break-even point is ideally matched to the natural expansion of the cargo market and will begin immediately to operate at profitable load factors.

The Canadair Forty Four is flying now and is in production for the three largest all-cargo carriers in the United States, and can be introduced into existing fleets as early as January 1961.

The Canadair Forty Four can operate in and out of all airports presently used by four-engined piston-powered aircraft. For example, at such an important airport as Midway, in Chicago, with only 6400' runways, the Forty Four can take off with 90% of its maximum payload and fly non-stop to San Francisco.

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GERMAN Kria sailplane lands with speed brakes extended at 90 deg. V-tail lessens damage in off-field landings.

German Kria Glider Built of Synthetics

By Edith Walford

Geneva, Switzerland—Single-seat Kria glider, which made its first flight in 1958 and presently is completing its flight tests, is the second German glider to be made chiefly of lightweight synthetic materials (AW Nov. 30, p. 63).

It was designed by Dr. Richard Eppler. Hermann Nägele was responsible for its development and final assembly. Both men are members of the Academic Group of Pilots (Akademische Fliegergruppe), a department of the Technical College, Stuttgart. They also belong to the Wolf Hirth glider design and construction team which has financed the project. Flugzeugbau Wolf Hirth GmbH., Nabern/Teck, built the Kria prototype.

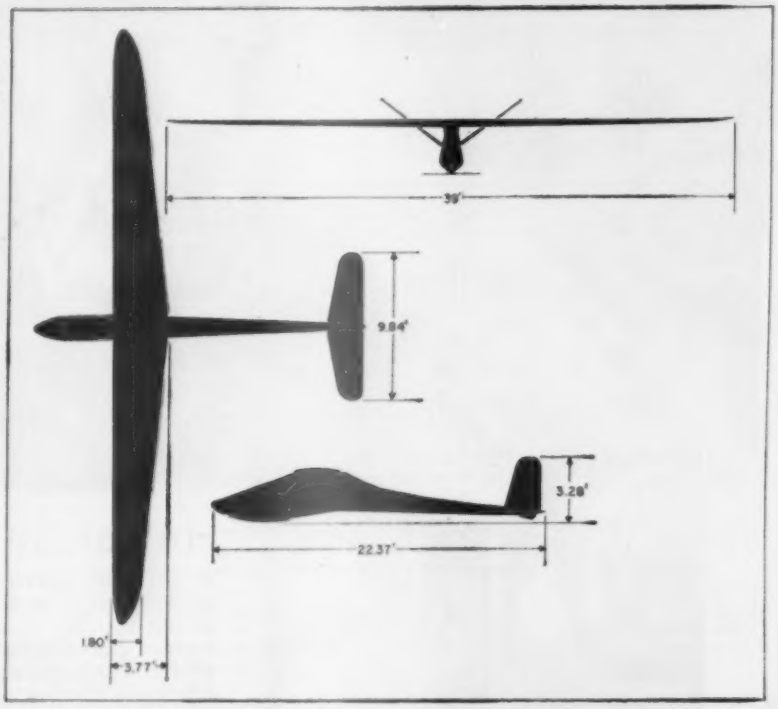
The same team of glider engineers also developed and built the Kria's predecessor, the first all-plastic FS 24 Phoenix sailplane. The Phoenix made its first public appearance in the open class of the German Glider Contest held at Karlsruhe-Forchheim last summer (AW Aug. 17, p. 119).

Basic Construction

Basic construction and general appearance of the much smaller Kria is very similar to the Phoenix. Its 39 ft. span (Phoenix has a 52 ft. span) puts it in the class of gliders which is becoming increasingly popular. One of the main reasons for this is that gliders in this category can easily be moved from place to place, even through narrow village streets.

The Kria's wings are slightly curved and in transport lie across the roof of the towing automobile or truck so that very little of the wing surface hangs out over the rear end of the vehicle to offer an obstruction.

Noteworthy is that the supporting surfaces are built as one single unit which reduces the total weight. The company also expects this feature to re-



KRIA'S empty weight is 253 lb. Minimum sink rate is 2.30 fps. Polyester resin, glass fiber-reinforced skin covers balsa wood frame. Glider is of sandwich construction.

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Foam core construction	Shock padding (high hysterisis)	Elastomer coupling	Control knobs & accessories	Instrument scope boots
Helmets and liners	Clothing insulation & liners	Oxygen hose and masks	Electronic encasing	Airless wheels & tires
Packaging & flotation	Air & liquid filtering	Window and hatch gasketing	Applicable hardware	Applicable hardware

Kria Glider Specifications

Dimensions	
Span	39 ft.
Length	22.37 ft.
Height	3.28 ft.
Wing area	106.17 sq. ft.
Span of tail unit	9.84 ft.
Depth of elevator unit	2.62 ft.
Root chord	3.77 ft.
Tip chord	1.80 ft.
Aspect ratio	14.4
Weight and Loading	
Empty weight	253 lb.
Useful load	220 lb.
Performance	
Best glide ratio	30
Minimum sinking speed	2.30 fps.

sult in lowering the ultimate cost.

Another special feature is the V-shaped tail section which is of aerodynamic advantage and also lessens the possibility of damage in off-field landings.

Like the Phoenix, the Kria is of sandwich construction and its polyester resin, glass fiber-reinforced skin covers a balsa-wood frame. Attention has been given to making the design as uncomplicated as possible in order to reduce to a minimum the labor cost of any future production series.

Best glide ratio attained in recent trials was 30 and minimum sinking speed was 2.30 fps.

When the Kria has concluded its present series of flight tests including visual-flow tests with wool tufts attached, the manufacturers plan to produce a first production run of the glider and to be able to market it "at a reasonable price."

PRIVATE LINES

Photo mapping of the Mekong River valley and corresponding ground support in Thailand, Laos, Vietnam and Cambodia is being handled by Photographic Survey Corp., Toronto, and Spartan Air Services using a Douglas DC-3 which carries a radar profile recorder for noting elevation changes, in addition to camera equipment.

Three for one stock split, increasing authorized capital from $1.5 million to $5 million common $1 par value shares, was approved by stockholders of Cessna Aircraft Co., Wichita, Kan. Holders will receive two additional shares for each one held as of Feb. 8, the new shares being issued Mar. 4.

Kellett Aircraft Corp. will survey flight stability in helicopters under a prime contract from Army Transportation Research Command.

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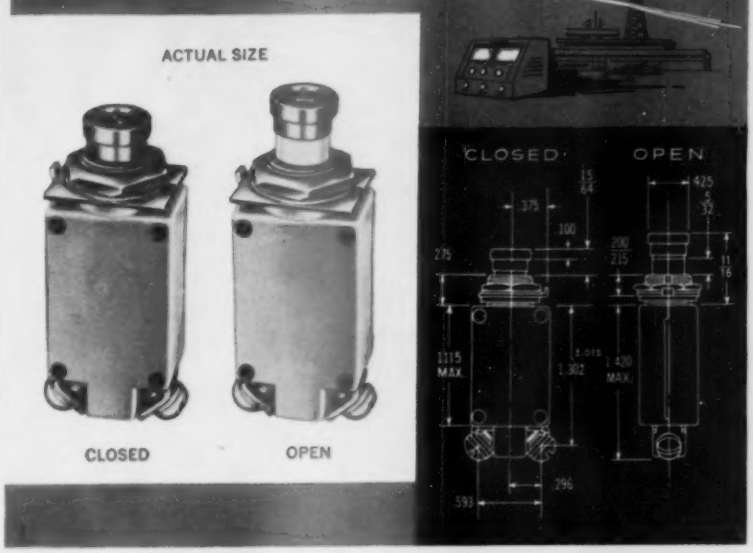

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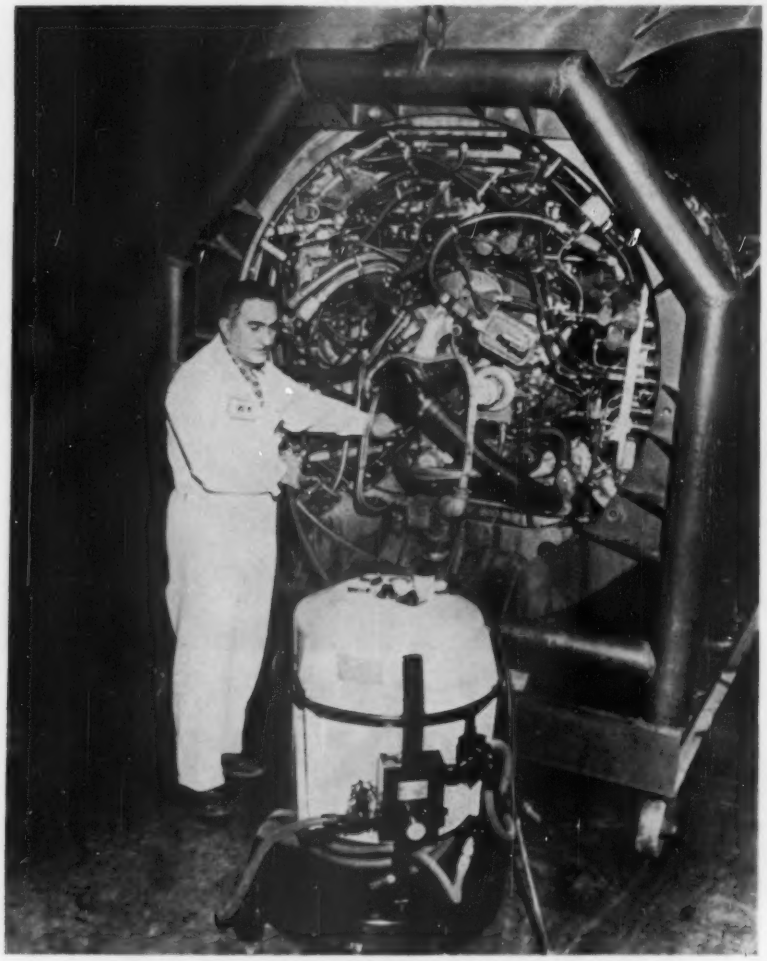

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Pre-oiler services a Wright R3350 reciprocating engine at Lockheed Aircraft Service, New York. The pre-oiler raises the temperature of 15 gal. of SAE 60 oil from 135 to 205F in 12 min. Oil is delivered at the rate of 10 gpm. at variable pressures up to 150 psig. The Navy will employ the equipment in the Antarctic for servicing helicopter and aircraft piston engines. The manufacturer of the pre-oiler, Narda Hydraulics Corp., says that the unit will lubricate and preserve jet engines.

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Test unit checks efficiency of air turbine starters. Initial deliveries are being made to Northwest, SAS and Air-India.

The test stand, designed for commercial airline overhaul facilities, requires a 17 psig., 435F air source. Both an overspeed checkout and an inertia mass pad are included in the unit. Standard AND 20002 mounts, duplicating starter mounts on all present commercial turbines, are used to attach starters. Starter run-up is accomplished by varying air pressure and temperature. Test unit is mounted to any firm base through a 2-in. cork blanket by four bolts. A 60 cycle per rpm. transducer for connection to a facility speed counter is being furnished with the test unit.

AiResearch Mfg. Division, 402 S. 36th St., Phoenix, Ariz.

Liquid Oxygen Trailer

Semi-trailer for transporting liquid oxygen, liquid nitrogen or liquid argon has a capacity of 4,000 gal. Trailers, developed for the Air Force to meet MIL-S-26196A, are insulated to limit evaporation loss to ¾ of 1% per day.

The trailer consists of a double-walled stainless steel tank mounted on a tandem axle military trailer equipped with air brakes. Liquid oxygen is transferred by means of two 3½-in. dia., 20-ft.-long hoses. The trailer measures 35 ft. 6 in. in length, 8 ft. wide and 11 ft. high; gross weight is 65,750 lb. Maximum pressure is 50 psig.

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Miniature two-axis free gyroscope for missile guidance applications weighs less than 2½ lb. and measures 4 in. x 2.75 in. diameter.

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Thermal Insulation Paper

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Minnesota Mining and Manufacturing Co., Dept. S9-431, St. Paul 6.

Jet Ejectors Studied For Vertical Takeoff

New York—Thrust augmentation for vertical takeoff by means of jet ejectors is being studied by Lockheed Aircraft under Army contract. The ejector propulsion system is proposed for an Army surveillance aircraft which would require VTOL capability, a higher subsonic speed than that attainable with rotor or propeller vehicles, and good low altitude performance.

The ejector principle was chosen as an effective means of providing sufficient vertical thrust without overpowering the aircraft for cruise requirements. The jet ejector uses a mixing chamber and a diffuser to entrain secondary air and to decrease the velocity of the primary jet. This creates a thrust augmentation at low speed which may be used to power the aircraft during vertical flight. Cruise power is obtained from direct jet engine thrust.

Lockheed is flying a tethered ejector test rig powered by two Fairchild J44 1,000 lb. thrust jet engines with two parallel ejectors. The company reports that the performance of the 2,650 lb. test rig proves the feasibility of the concept.

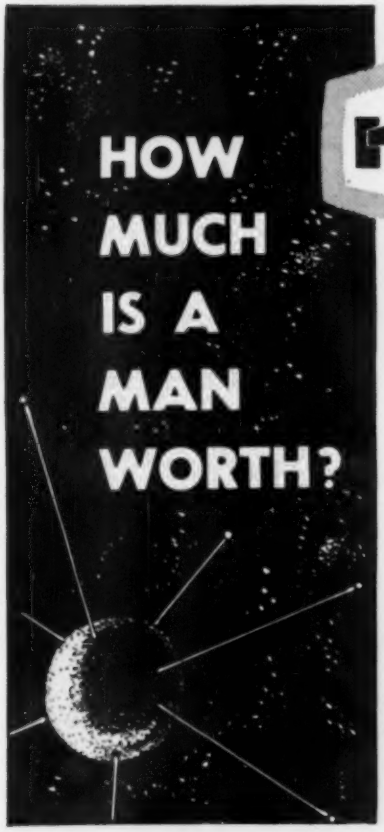
The test rig's J44 tailpipes extend rearward over two parallel ejectors, each equipped with 20 pairs of diffuser nozzles on the lower side. Ground effect studies indicated a reduction in thrust of a single ejector as the diffuser approached the ground plane. The use of parallel ejectors eliminates this problem.

Ground effects of the Lockheed VTOL device, described at the annual meeting of the Institute of the Aeronautical Sciences in New York, result in a magnitude of 85% augmentation at a height of 18 in. The ground effects are lost as the test rig rises through a height of 8 ft.

The ground blast of the ejector rig

Boeing-Wichita Laboratory for Hazardous Tests

Boeing Airplane Co. has developed a laboratory for hazardous tests at its powerplant test center, Wichita, Kan. Temperature test chamber (background) has a range of —100F to 250F. Other installations include an altitude-temperature chamber which can simulate 70,000 ft. altitudes and —80F to 250F temperatures, and salt spray and sand dust chamber.



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Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

Compass Calibrator

Precision compass calibrator, called a "rictometer," shields out 99% of earth's horizontal magnetic field and produces internal field which can be adjusted through 360 deg. in azimuth. Device was developed by General Electric Instrument Dept. for A3J but is expected to have commercial applications for calibrating gyro-compass transmitters. Device is far less expensive than conventional Helmholtz coil system formerly needed, GE says.

is described as low for a VTOL aircraft. At 20 ft. from the side of the device, the air velocity is 35 fps. and the temperature is 160F. Personnel may walk to the side of the rig while it is hovering, and the noise level, recorded at 20 ft., is 115 db.

The test device, originally fitted only with a pilot's seat, has been modified to permit visitors to ride the VTOL rig. Development problems of the ejector augmented VTOL rig included roll control and re-ingestion of hot gases. The reliability of the device is described as excellent with no failures during the 18-month test program.

B-58 Escape Capsule Uses Gas Generator

Ft. Worth, Tex.—Air and watertight escape capsule for the Convair B-58 Hustler being developed by Stanley Aviation Co. will incorporate dual gas generators to power the capsule pre-ejection sequence, allowing crewmen to go through the sequence twice.

If a Hustler crewman activates the pre-ejection system in anticipation of leaving the aircraft, then finds he can stay with the plane and even return to normal aircraft pressurization and air conditioning systems, he can do it safely since the second gas generator is available if he has to eject later.

The Hustler capsule, which has automatic flight stabilization to block tumbling at high speeds and altitudes

as well as a parachute recovery system, has provisions for absorbing water landing shock safely and contains stabilization and flotation gear to keep the capsule upright in the water for at least three days. Flotation tests were scheduled at Marblehead Point, Clinton, Ohio, on Lake Erie, with a dummy riding the capsule, and a human volunteer later riding for three days.

Pre-ejection sequence for the Hustler capsule has the crewman pulling a mechanical trigger to start the gas generator, developed by McCormick Selph Associates, each of which weighs 3¼ lb., or 7 lb. per capsule. Gas from the generator drives an actuator system which lifts the crewman's knees up against his chest and simultaneously retracts his feet against the forward edge of the seat, then activates a reel system which pulls the individual's torso harness back, locking his body and head against the seat.

When these two operations are complete, other capsule components lower the three canopy doors into position around the crewman and pressurize the capsule immediately.

Here the crewman can decide whether to go or stay—if he stays in the capsule, he can operate all necessary controls from within the capsule to continue the flight and complete the mission. If he opens the capsule and returns to airplane pressurization and air conditioning systems, he still can go through the pre-ejection sequence once more, after which he either has to eject, keep the capsule pressurized for the rest of the flight, or if he again depressurizes the capsule, he has to complete the flight using normal systems.

Time from initiation of the McCormick Selph gas generator until the pre-ejection sequence is completed and crewman is ready to eject ranges from 0.5 to 0.8 sec.

Spherical Bearing Has Segmented Ring

New York—Extended spherical bearing life under severe vibratory, temperature and load conditions of aircraft and missile applications is indicated by tests of a segmented ring self-aligning spherical bearing.

The bearing, called Smith/align, is in production at the Accurate Bushing Co.'s Smith Bearing Division, Newark, N. J. Aircraft application for self-aligning bearings include landing gear, arresting hooks, engine mounts and control linkages.

Missile applications include electro-hydraulic servoactivators in guidance systems and missile control system linkage. The Smith bearing is intended for application where severe load and vibration, high and low temperatures are

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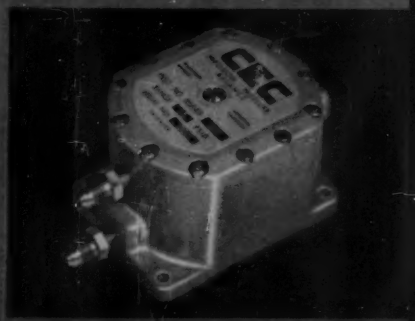
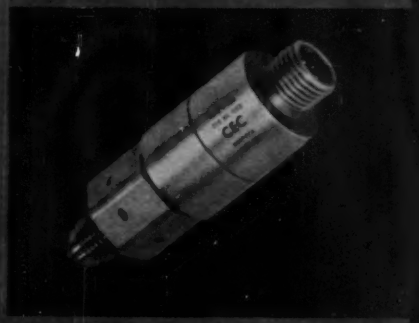
4-332 MINIATURE PRECISION PRESSURE BALANCE

Less sensitive to acceleration and vibration . . . more stable than larger pressure balances—that's the record of this miniature device that's easier to use in wind tunnel pressure measurement and control applications. This device can be held in your hand . . . measures a scant 4" x 3" x 2½". CEC also offers pressure balances in high speed and standard models. *For complete information, write for Bulletin CEC 1547-X4.*



4-326 STRAIN GAGE PRESSURE TRANSDUCER

In such demanding applications as rocket test stands, this small but rugged transducer measures high-frequency gage or absolute pressures to 10,000 psi. It stands up to severe acoustical noise . . . maintains low acceleration response . . . is extremely stable at 1,000 g's at temperatures from −320°F to +300°F. The 4-326 is just one of 13 types of CEC transducers. *For details on this finest achievement in strain gage transducers, write for Bulletin CEC 1620-X5.*



4-380A LOW PRESSURE POTENTIOMETER

Put this pot to work in your toughest environment—it takes 25 g, 2 KC vibrations for hours, with negligible change in calibration. The 4-380A covers a pressure range of ±1 psi to 100 psi. When operated over most pressure ranges at −65°F to +200°F, it shows a temperature effect of less than 1%. Choose from absolute, gage and differential models. CEC high pressure pots are also available. *For specifications, write for Bulletin CEC 1604-X1.*

Transducer Division CEC

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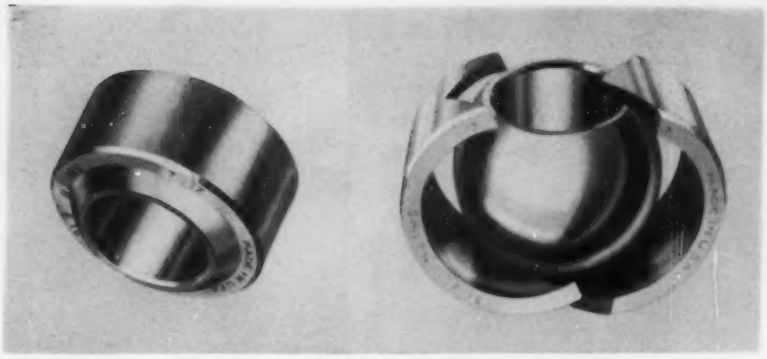

SMITH/ALIGN bearing separates at V joints; each segment clings to the sphere.

creating problems and where reliability is of prime importance.

The unusual feature of the bearing is the two-piece ring separated at V joints. Each segment actually extends more than halfway around the ball so that each segment clings independently to the ball. Neither of the matched segments can separate from the ball under normal operation. The bearing is assembled by positioning the ball so that it is 90 deg. to its normal operating position in its race. Rotating the ball into operating position locks the bearing together and it is ready for insertion in place.

This self-locking segmented ring design permits the use of hardened outer rings with full bearing areas. The fitted joining surfaces where the ring segments join are precision ground with polished edges to avoid scratching the ball. Special cast alloys may be supplied for the ring when needed.

The bearing assembly illustrated, for a high temperature application, has no lubrication provisions. Smith says, however, that grease grooves can be provided inside or outside the rings. Lubrication access to the inner grease groove is provided by flattening the points of the V joints creating a channel to the inner ring. Lubrication to the ball also may be provided.

In addition to the manufacturer's tests, samples of the bearings have been sent to various aviation companies. Smith, on the basis of generally favor-

Transporter-Erector Developed for Rocket Engines

Transrector, weighing 80 tons, is capable of handling solid or liquid rocket engine units up to 35 ft. long, 85 in. in diameter and weighing 80,000 lb. The equipment will be used to transport rocket engines to test-firing sites and to place them in horizontal or vertical position for static test. The transrector is built by the Hufford Division of Siegler Corp. under $225,000 contract from the Thiokol Chemical Corp.

VOUGHT TAKES AIM AT THE SUBMARINE

Submariners, submarines and sub-launched missiles are intimate friends of a special ASW department at Chance Vought.

Vought's ASW team, drawing on a ten-year backlog of comprehensive submarine experience, is working with the Navy and its Fleet units to develop advanced means of protection against attack from under the seas.

For the past ten years, Vought engineers have cruised aboard missile subs in pioneering voyages. They have learned the ways and habits of submarines. The company now is applying this valuable insight into virtually every phase of antisubmarine warfare.

Vought's progress in ASW work is based on the application of concepts heretofore unused in the field. A superior sonobuoy has been developed. A long-range investigation of the use of satellites in submarine detection is under way. And entirely new techniques in the use of current . . . and future . . . aircraft systems are being explored with the purpose of achieving a complete antisubmarine defense.

In order to test the equipment and techniques under development for the Navy, Fleet submarines and aircraft will be operated for Vought under a broad variety of environmental conditions. Vought's experienced design and manufacturing teams can be counted on to transform their new concepts into effective defense systems, in whatever direction ASW leads.

Antisubmarine warfare, along with atmospheric missile and piloted aircraft development, are specialties in Vought's Aeronautics Division. Other major interests are being aggressively advanced in the company's Astronautics, Electronics, Range Systems, and Research Divisions.

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Maxim Division/Dept. 75
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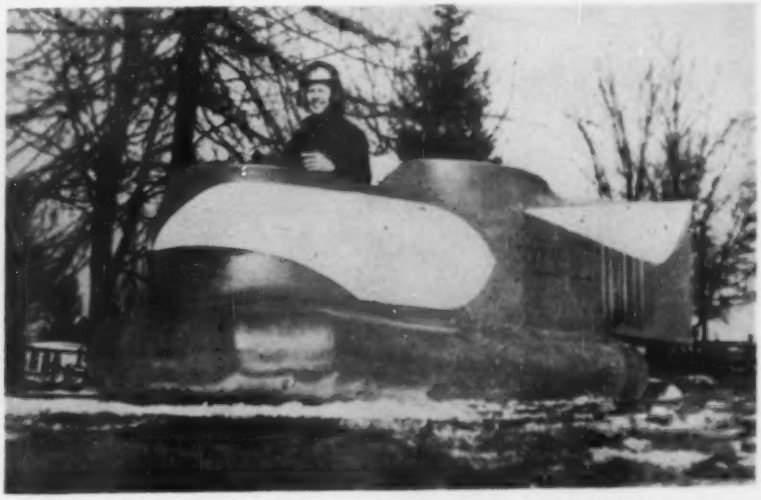
able reports, is producing the new bearings in standard sizes. The chief advantage of the segmented ring bearing, Smith says, is the controlled precision which can be built into the fit of the bearing ball with the matched rings, all ground and polished as a set. Ready inspection of the finished product also is cited as an advantage. The higher cost of the Smith/align bearing will limit its use critical applications where reliability and long life are needed.

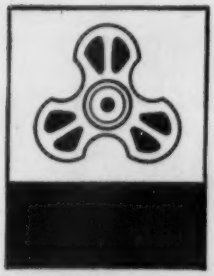
Gross Weight Rise Sought For Lodestar With JATO

Lockheed Lodestar, authorized a takeoff gross weight of 19,000 lb. using 1,350-hp. Curtiss-Wright engines and 18,500 lb. with JATO bottles installed, is expected to receive an authorization to increase maximum takeoff gross weight to 21,500 lb. with the JATO bottles.



U.S., Australian Ground Cushion Vehicles

Fletch-Aire Glide-Mobile (above, with inventor Charles Fletcher of Sparta, N. J., at the controls) is a new ground cushion vehicle that has successfully flown 4 to 6 in. off the ground. Unit weighs 243 lb. and is powered by a 72 hp. McCullough engine which turns a 50 in. dia. propeller. Fletcher, a Reaction Motors engineer, says the car will travel at about 26 mph. on a no-wind day, carrying one man. Control is achieved through guide vanes. Below is another ground cushion vehicle, the Hovermobile, test flown at Adelaide, Australia, by its inventor, Harold Clisby. Machine is 7 ft. in diameter and weighs 160 lb.; Clisby is standing in the cockpit. Powerplant is a 30 hp. aircraft generator auxiliary engine driving a 2 ft. dia. six-bladed propeller. Machine can rise 6 in. without pilot; control at present is vertical, gained through power, although minor direction control is achieved by leaning.



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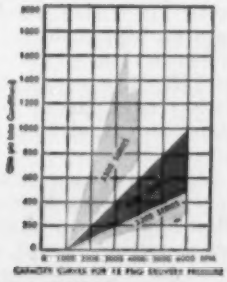

M-D BLOWERS, INC.
RACINE, WISCONSIN

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PRODUCTION BRIEFING

Air France expects to take delivery of 15 Sud Aviation Caravelle jet transports during 1960, thus completing its fleet of 24 Caravelles. The French carrier already serves 12 European capitals with its 1959 Caravelle deliveries. By the end of 1960 Air France will be operating the Caravelle on 60 routes serving most major cities in Europe, North Africa and the Middle East.

Austrian Airlines has signed a contract to buy six Vickers Viscount 837 airliners—making a total of 415 Viscounts sold. Four are to be delivered by Apr. 1.

Texas Instruments, Inc.'s Apparatus Division received a $4.5 million contract for advanced anti-submarine warfare system from Navy Bureau of Weapons. Delivery of the system will begin in 1961.

Japanese Guided Missile Council will send a 14-member survey mission to the U.S. and Europe in March to inspect manufacturing processes and operational sites of various weapons. Mission is headed by Yoshinaga Seki, president of Mitsubishi Electric.

North American Aviation will build 35 additional T-39 Sabreliner twin jet trainers for U.S. Air Force, increasing to 42 the total production order. Six will be fitted with all-weather search and range radar (NASARR), manufactured by Autonetics Division, for Tactical Air Command pilot training.

Fairchild Engine & Airplane Corp. is constructing an addition to its Plastics Branch at Copiague, N. Y., which will provide 22,500 sq. ft. additional space. The expansion, to be completed next month, will provide more area for production of reinforced plastic items as radar parabolic reflector dishes, Titan ICBM components and solid rocket casings.

Convair Division of General Dynamics Corp. will modify nine F-106 test aircraft to combat-ready all-weather interceptors under an $8 million contract from San Antonio Air Materiel Area, and will purchase long lead time items for modification of another 26 F-106s. Program for converting total of 35 F-106s will cost about $20 million.

Army Ballistic Missile Agency has invited bids on a barge to transport Saturn space booster from development site at Redstone Arsenal, Ala., to Cape Canaveral, Fla. Delivery of the vessel, 180 ft. long with a displacement of 450 tons, is scheduled for late 1960. Barge will be propelled by a tugboat.

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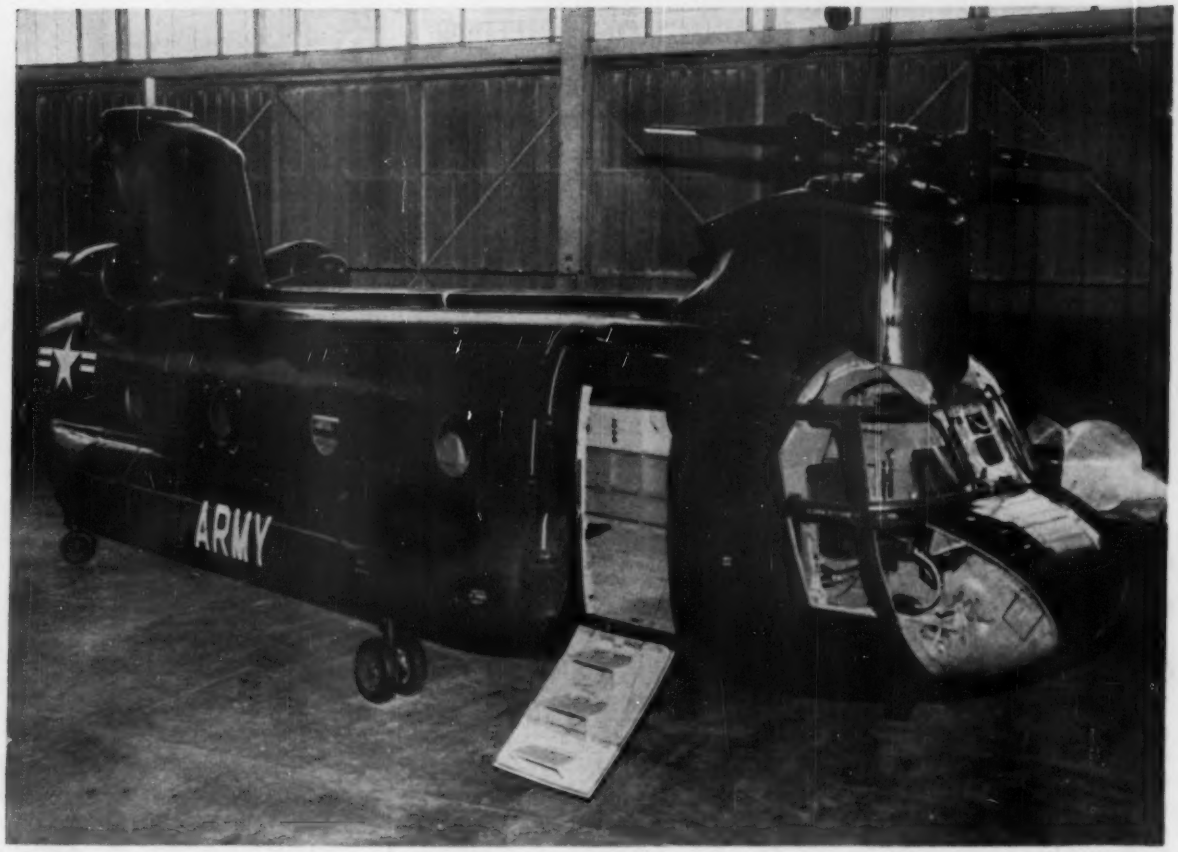


VERTOL YHC-1B, with a maximum gross weight of 33,000 lb., is 51 ft. in length, 12 ft. 5 in. in width, and 18 ft. 6.6 in. in height. Overall length, blades unfolded (full diameter of both rotors) is 98 ft. 2 in. Average cruise speed is 130 kt.

First Design Details of Vertol YHC-1B

By Robert I. Stanfield

Morton, Pa.—First design details of Vertol's tandem rotor, turbine-powered YHC-1B Chinook, an Army battlefield mobility vehicle now in mockup form, point to a medium transport helicopter with a normal gross weight mission of two tons internal payload and a maximum alternate gross weight mission of close to eight tons external payload. Top speed is specified as 152 kt.; cruise speed, 130 kt.

Chinook design was aimed at simplicity and ease of maintenance. The objective is a helicopter that can be maintained at organizational level by a mechanic relying solely on a standard U.S. Army tool box. It will also have all-weather, day-night flight capability.

Powerplants, selected by the Army, will be two Lycoming YT55-L-5 free turbine engines (AW May 18, 1959, p. 42) with a military rating of 1,940 shp. each, and which are programed up to 2,200 shp. Dry weight of each engine is 563 lb. The rotorcraft can absorb the full power of both engines at sea level on a standard day, according to Vertol.

The YHC-1B will be used by the Army as a means of transport for personnel, weapons and cargo in both combat and rear areas. The cabin cross-section configuration is compatible with the Army family of vehicles the helicopter can haul. The cabin is 78 in. high, with an upper corner radius maximum of 15.5 in. Width is 90 in. Length, from ramp hinge-line to forward bulkhead, is 30 ft. The constant cross-section fuselage can be easily expanded in length.

Chinook Cabin

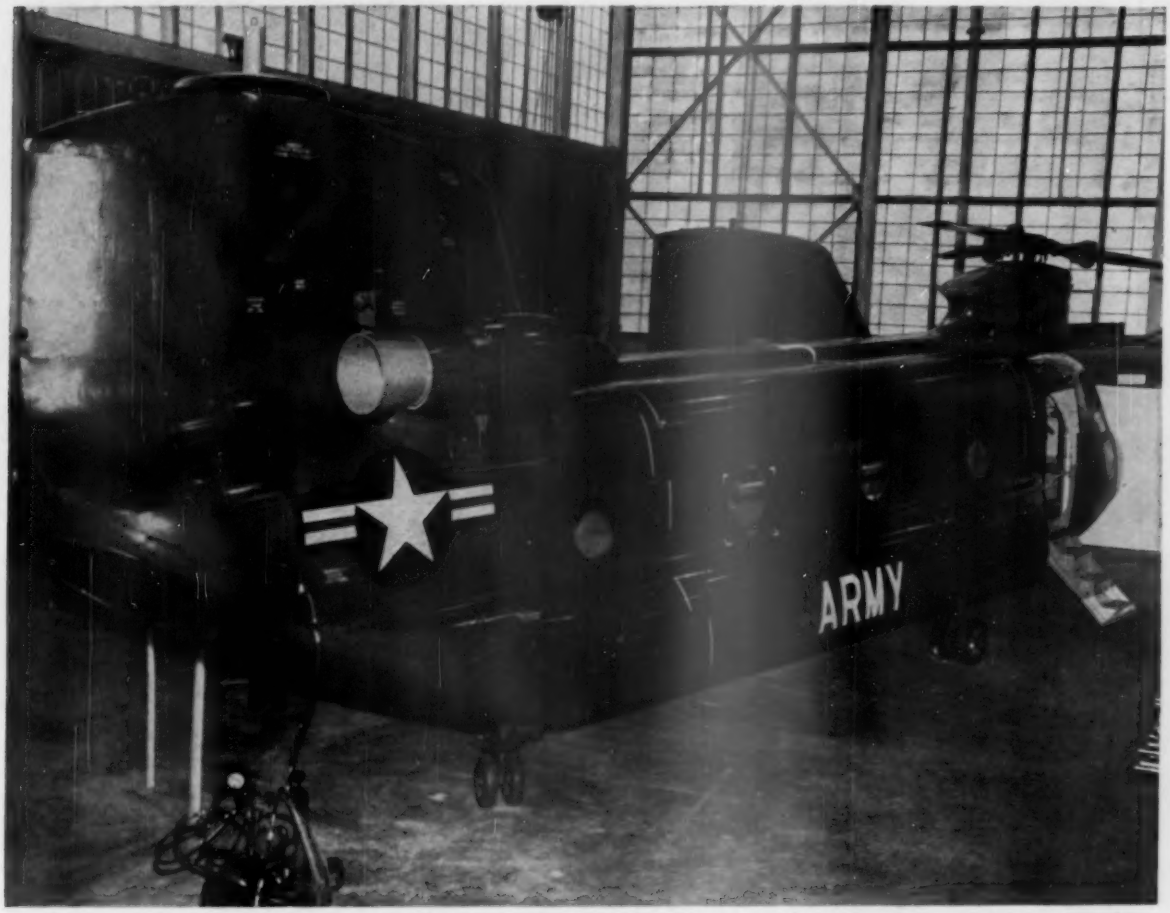
Cabin includes provisions for 32 troops with 20 in. of space per man, plus troop commander in the jump seat, or 27 paratroops with 24 in. of space per man. Support structure will mount 24 litters. The Chinook also has missile applicability; it can carry all components of the Pershing system (though not all in one load).

Initial Army order for five Chinooks, placed through USAF's Air Materiel Command, was in March, 1959. Service is programed for five more, with money set aside out of Fiscal 1960 funds. Initial AMC contract, AF33(600)-39492, was for $20 million. Hard tooling designed for high production is now under way at Vertol's Morton plant. The first YHC-1B is scheduled to roll out this November, last of the initial five the following April. First flight will be early in 1961.

Additional design features of the Chinook, as stressed by Vertol, include:

• **Rear loading ramp** which can be left open or partially opened, or can be removed for flight. This permits transporting of extra-length cargo internally, and facilitates in-flight parachute or free-drop delivery for specialized missions. Ramp is designed as a work platform and can be adjusted to any required height.

• **Tri-service aircraft,** compatible with Navy carrier operations as well as with USAF and Army operations. Design features, said not to penalize the Army version, include blade flap restrainers on rotor blades for high-wing carrier conditions; kneeling provisions (will partially retract) of aft landing gear, for hangar deck clearance; provisions for amphibious operations in accordance



CHINOOK rotors sit high on the airframe to allow for landings in brush. For carrier-based helicopters, the over-all height can be reduced to 17 ft. for hangar deck stowage by partial retraction (kneeling) of the aft alighting gear.

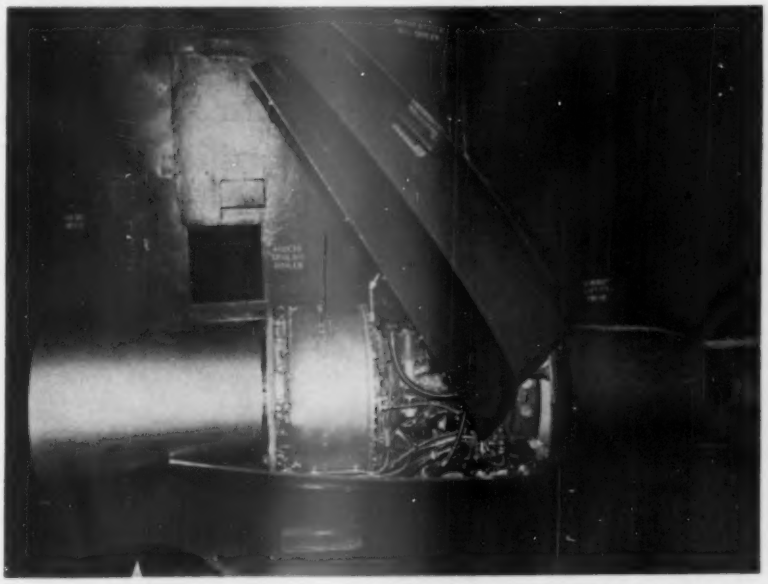
with Navy requirements (in emergency present Army version will float).

• **Fuselage is sealed** in production; the helicopter is completely integrated for all-weather operation, including windshield, rotor blade and engine inlet deicing. Flight instrumentation includes independent dual flight controls.

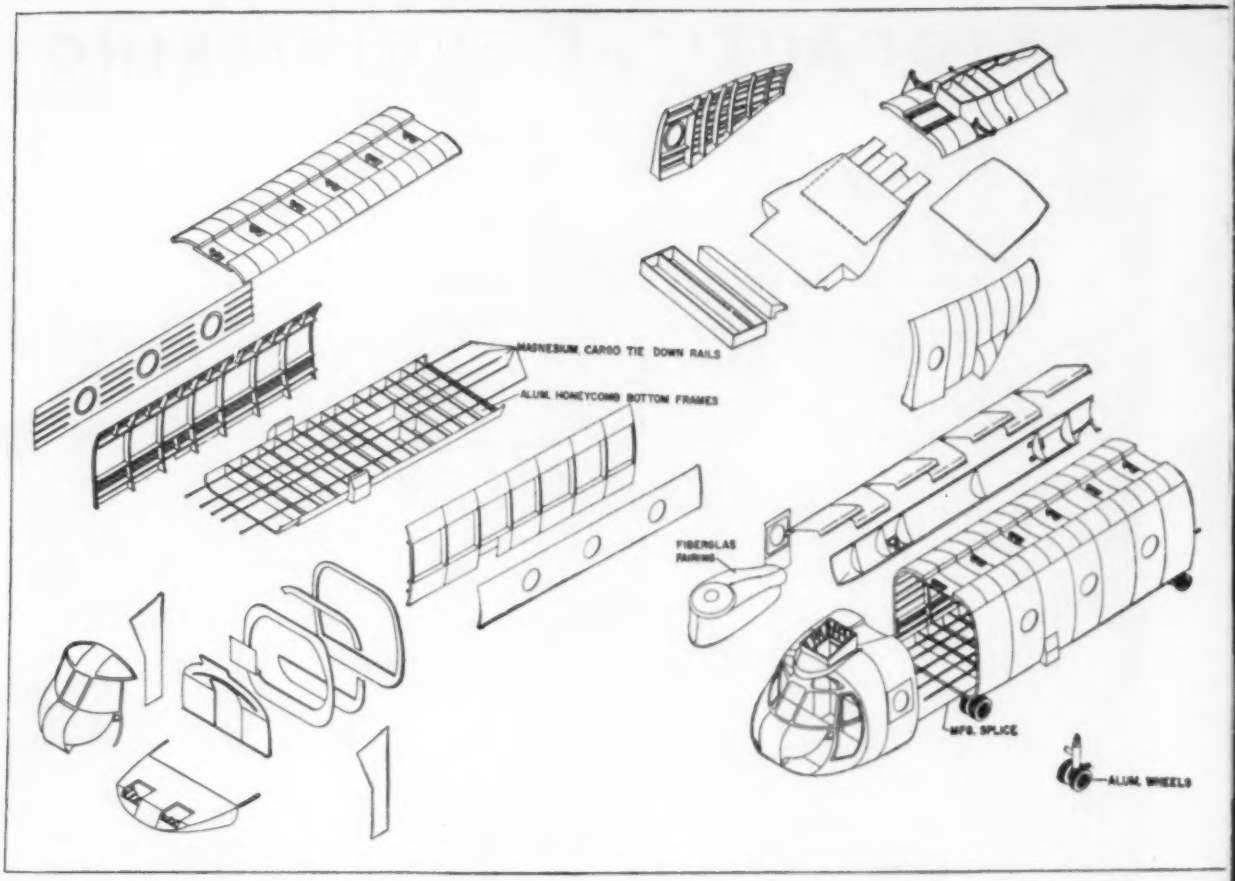
• **Auxiliary power unit** is capable of operating all hydraulic and electrical systems with rotor blades stopped. The APU also will provide power to start engines down to −65F ambient.

• **Maintenance davit,** to make the helicopter self-supporting and eliminate the need for special workstands, has been designed for the YHC-1B. The davit parts weigh about 340 lb., though production models will be lighter. Designed to take 1,700 lb. of weight, easily transportable in the helicopter, the davit is capable of removing rotor hubs, transmissions and engines, and can be handled by three men. The biggest single item, the beam and upper part of the davit, weighs 190 lb.

• **Cowlings, doors,** etc. of the Chinook



YHC-1B powerplants are three-point mounted. Work platforms in pods provide access to engines. A hinged cowling system permits servicing without removal of the engine.



CHINOOK'S forward fuselage section is completely fabricated and assembled prior to splicing to the cabin section. Pods, located on each

are hinged. The cargo compartment itself is clean; there is no need for any internal maintenance. Emphasis has been placed on serviceability at ground level: the electrical system, control system and fuel system are serviced from within, or at this level. Platforms are provided for high sections.

• **Engine and transmissions** systems use a common oil. Engines, with davit erected, have been removed and replaced in less than 20 min. Right and left 315-gal. fuel cells are interchangeable, with growth capacity in the pods for additional fuel (permanent fuel, that is). Long range ferry tanks would go in the cargo compartment.

• **Transmission system** is designed for the full military horsepower rating of the engines (3,880 shp.) with space provision incorporated for growth to 4,400 shp. Dual control system hydraulic actuators at each rotor head are powered by independent hydraulic systems.

• **Dual flight stability** systems include the Signal Corps-developed Universal Automatic Flight Control System AN/ASW-12 and the Vertol-developed augmentation system.

YHC-1B Specific Missions

Mission 1: Primary tactical mission, gross weight 23,500 lb. Deliver 4,000 lb. of internal payload to any point 100 naut. mi. distant and return with 2,000 lb. of internal payload. Average outbound cruise speed, 130 kt. Cruise time, 46 min. Average return cruise speed, 130 kt. Cruise time 46 min.

Mission 2: Alternate tactical mission, gross weight 25,800 lb. Deliver 6,000 lb. of internal payload to any point 100 naut. mi. distant and return with 3,000 lb. of internal payload. Average outbound cruise speed, 130 kt. Cruise time, 46 min. Average return cruise speed, 130 kt. Cruise time, 46 min.

Mission 3: Maximum alternate gross weight, 33,000 lb. Deliver 15,570 lb. of external payload to any point 20 naut. mi. distant and return. Average outbound cruise speed, 100 kt. Cruise time, 11.6 min. Average return cruise speed, 125 kt. Cruise time, 9.5 min.

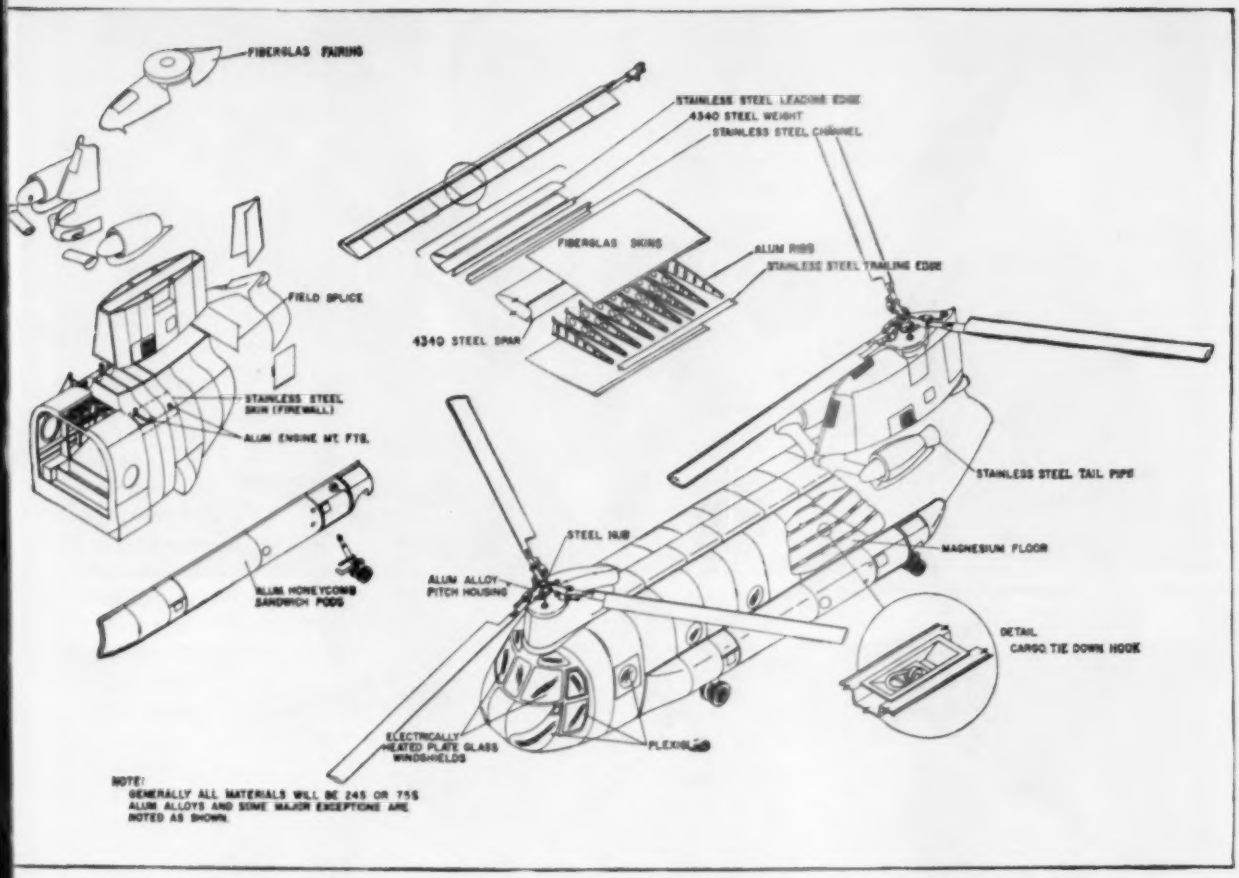
Mission 4: Ferry mission, gross weight 33,000 lb. Ferry range of 1,011 naut. mi. without refueling. Average cruise speed, 127 kt. Cruise time, 7 hr. 54 min.

Flight Status

The Chinook is an outgrowth of the Vertol-sponsored 107 prototype which was started in 1957 and followed by the Army YHC-1A helicopter, of which three will be built and the first two are on flight status at the Morton, Pa., site. The YHC-1B mockup completes all Vertol milestones to date.

All major Chinook components will be designed for service tours of 1,200 hr. The tours will be achieved through extended bench, ground and flight testing.

Powerplants are three-point mounted. A quick-disconnect panel provides for easy removal. Work platforms in both the right-hand and left-hand pods provide access to the engines. Engine cowling system is hinged to permit servicing without removal. The complete power



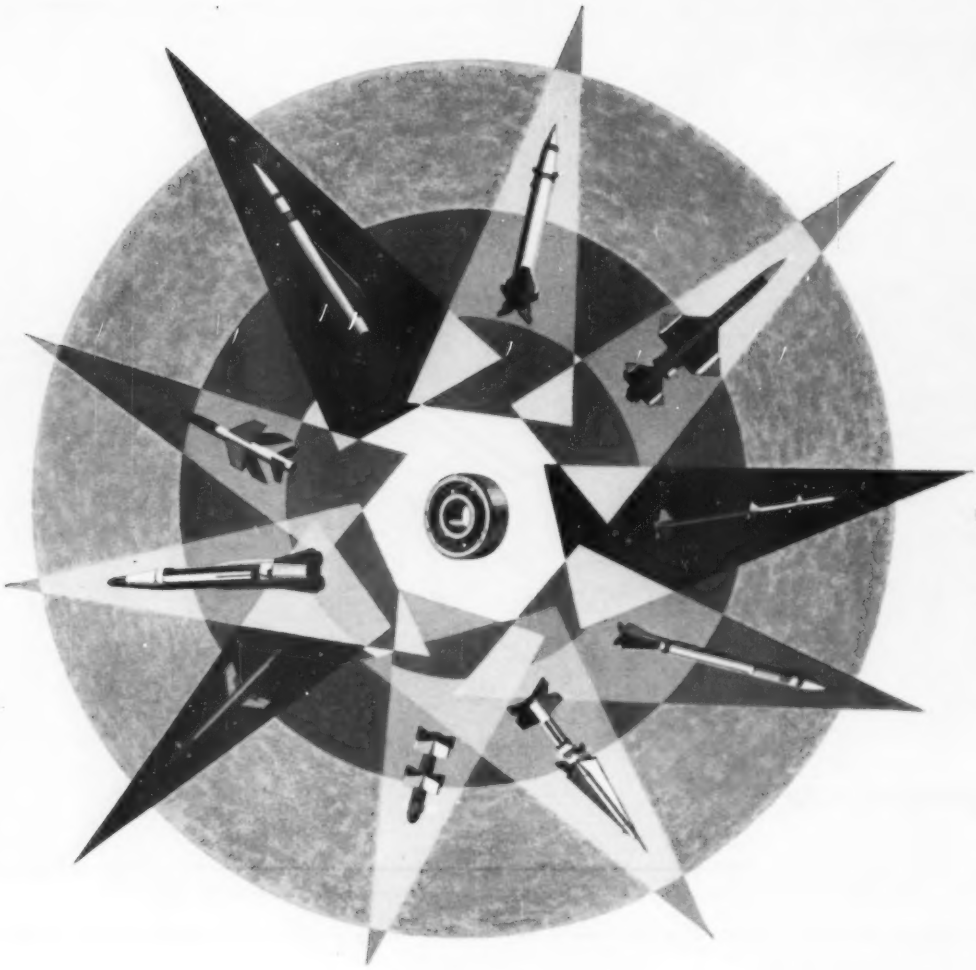
side of the fuselage, are constructed of metal honeycomb and are sealed and compartmented for water-based operations.

YHC-1B Weights and Performance

	Mission 1	Mission 2	Mission 3	Mission 4
Gross weight	23,500 lb.	25,800 lb.	33,000 lb.	33,000 lb.
Empty weight	15,459 lb.	15,490 lb.	15,651 lb.	15,246 lb.
Useful load	8,041 lb.	10,310 lb.	17,349 lb.	17,754 lb.
Payload	*4,000 lb.	*6,000 lb.	15,570 lb.	0
Radius of action	*100 naut. mi.	*100 naut. mi.	20 naut. mi.	———
Ferry range	———	———	———	1,011 naut. mi.
Mission cruise altitude	sea level	sea level	sea level	5,000 ft.
Mission cruise speed (initial/average)	*130/130 kt.	*130/130 kt.	†100/125 kt.	104/127 kt.
V_{max}, sea level, military power	152 kt.	151 kt.	144 kt.	144 kt.
V_{max}, sea level, normal power	149 kt.	147 kt.	139 kt.	139 kt.
V_{max}, 5,000 ft., normal power	146 kt.	143 kt.	117 kt.	117 kt.
Hover ceiling (OGE), military power	11,500 ft.	8,600 ft.	sea level	sea level
Hover ceiling (OGE), military power, 95F	*6,000 ft.	3,500 ft.	———	———
Hover ceiling (OGE), military power, 100F	5,400 ft.	*3,000 ft.	———	———
Hover ceiling (IGE—10 ft. off), military power	12,800 ft.	10,000 ft.	1,900 ft.	1,900 ft.
Service ceiling, normal power	18,900 ft.	15,600 ft.	7,100 ft.	7,100 ft.
Service ceiling, military power—engine out	8,800 ft.	5,500 ft.	———	———
Vertical rate/climb, military power, sea level	2,700 fpm.	2,050 fpm.	0	0
Maximum rate/climb, military power, sea level	3,120 fpm.	2,660 fpm.	1,570 fpm.	1,570 fpm.

*(Guaranteed Performance)
†(Average outbound cruise speed/inbound cruise speed)

Note: All performance based on NASA standard atmosphere unless otherwise noted. All missions include landing with 10% of initial fuel as reserve except for Mission 3, which lands with a 10 min. fuel reserve.



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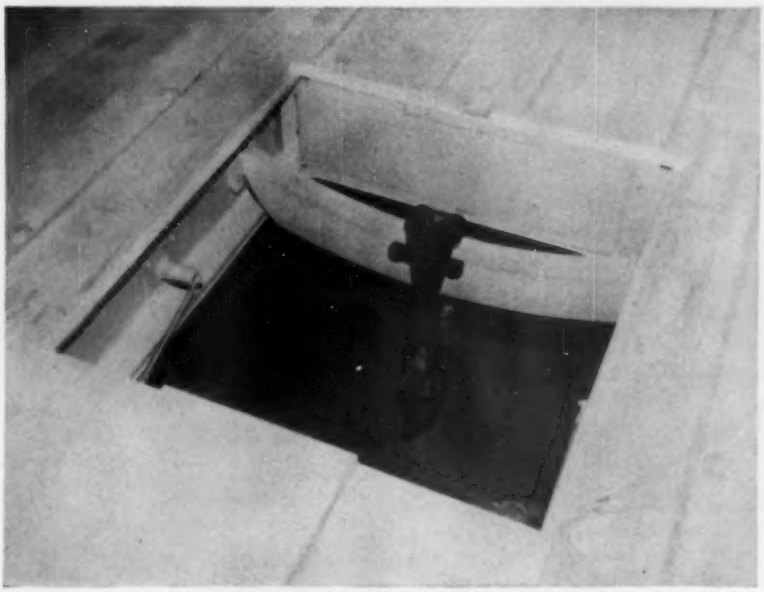
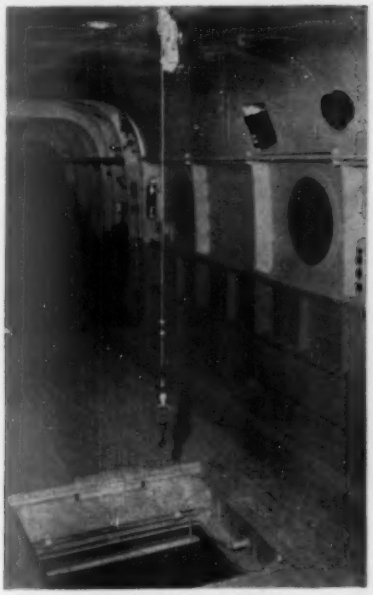
CHINOOK davit (left), designed to take 1,700 lb. of weight, is capable of removing rotor hubs, transmissions and engines, and can be handled by three men. Forward rotor head (right) is serviced from integral work platforms hinged in the pylon.





EXTERNAL cargo hook (left), hydraulically actuated, is capable of suspending eight tons. For rescue operations (right) the cable is reeved upwards just aft of the cockpit, taken along ceiling to hatch and lowered. Pulley block contains a cable cutter.

plant can be removed without disassembly.

The forward rotor head and the upper forward controls, including two hydraulic actuators, are serviced from integral work platforms through the two hinged clamshell doors in the forward pylon. The aft rotor head and aft upper controls, including two dual hydraulic actuators, are serviced through the access fairing from integral work platforms in the aft pylon.

Daily greasing of the rotor head swashplate and rotor controls has been eliminated since all hinge bearings and the swashplate bearing are completely submerged in oil at all times. Oil levels of reservoirs are determined from sight gages.

Airframe Details

Chinook's forward fuselage section is completely fabricated and assembled prior to splicing to the cabin section. Crew compartment incorporates jettisonable doors for both pilot and copilot. The main cabin door, on the right side, is composed of an upper hinged section which may be opened in flight and a lower section with integral steps that opens out and down. This section, 36 x 46 in., is jettisonable.

Cabin fuselage consists of four panels, the crown, left and right side, and the bottom. The lower section, when covered by the extruded magnesium cargo floor, forms a series of watertight compartments. For emergency water landings, the bottom skin and the cargo floor are sealed.

The floor is designed for a distributed load of 200 psf. and a concentrated load of 1,000 lb. per wheel in the center section. Outboard portion of the floor (the treadway) is designed for a 2,500 lb. wheel load. Floor contains 83 5,000-lb. tie-down fittings and eight 10,000-lb. fittings. There are also four

GPL data handling

equipment for the Federal Aviation Agency

GPL's experience and ingenuity are at work assisting the FAA Bureau of Research and Development in the creation of a modern data processing central, the heart of tomorrow's air traffic control system. The central will receive up to 400 aircraft flight plans hourly, "remember" 1,000 such plans simultaneously and transmit 200 plans and 800 updates hourly to adjacent centers. Automatic processing and unique displays of such data will make significant contributions to the efficient control of aircraft in en-route, transition and terminal areas.

The FAA data processing central is just one of a number of airborne and ground-based programs reflecting GPL's capabilities in the data handling field. These programs are supported by GPL's proven ability to understand the customer's problem and capacity to anticipate future requirements. The GPL organization is "systems oriented," offers complete capabilities ranging from research, engineering and manufacturing to customer service.

Why not put these broad capabilities to work on your problem?

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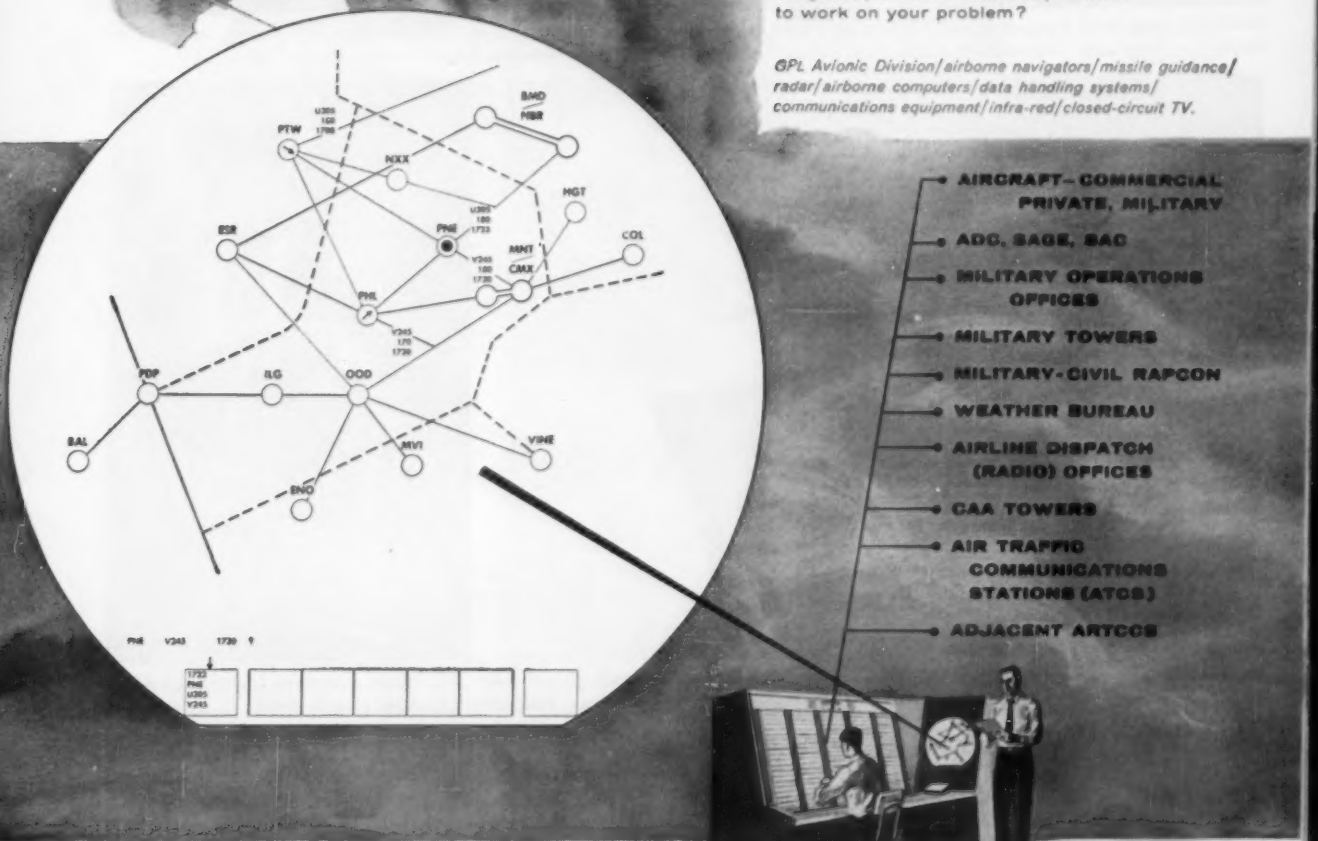

ENGINEERS — GPL achievements have opened some unusual research and development opportunities. Send resume to Personnel Director.

GPL DIVISION

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5,000-lb. fittings on the loading ramp.

Aft fuselage section, beginning at station 440, contains the combining gear box, the engines, loading ramp, cargo door and interchangeable upper pylon. Low-drag pods, located on each side of the fuselage, are constructed of metal honeycomb and are sealed and compartmented to provide stability and buoyancy for water-based operations. Serviced from the ground, they house the forward and aft alighting gear and electrical systems, plus the fuel cells.

Alighting Gear

Alighting gear is a fixed, quadricycle type. Forward gear uses fixed fully cantilevered type air-oil struts with twin 22 x 5.5 Type V11 8PR tires mounted on forged aluminum wheels. Aft gears are fully castering with twin 16 x 4.4 Type V11 8PR tires. Forced aluminum wheels are co-rotating, eliminating the need for shimmy dampeners.

The cockpit arrangement includes instruments for IFR operations. Basic flight instruments are arranged in "T" formation. Radio controls are located on the centered console. Starting and lighting switches, etc., and circuit breakers are located on the overhead panel. Caution light system is located below engine instruments and condition levers are fitted into the center quadrant. Pilot's seats can be adjusted up and down, forward and aft, and, for towing purposes, to 15 deg. of tilt.

Drive System

Growth potential of the drive system, to 4,400 shp., will be accomplished by gear tooth and bearing changes. There will be no change required in the castings. Components are designed for a minimum service life of 3,600 hr. and an overhaul life of 1,200 hr. Engines, of 1,940 hp., turn 14,200 rpm. Engine nose box, 1,940 shp., turns 11,200 rpm. Combining gear box, of 3,880 hp., turns 6,600 rpm. (synchronizing shaft speed). Rotor box of 2,328 hp. (input), turns 215 rpm. (rotor rpm.).

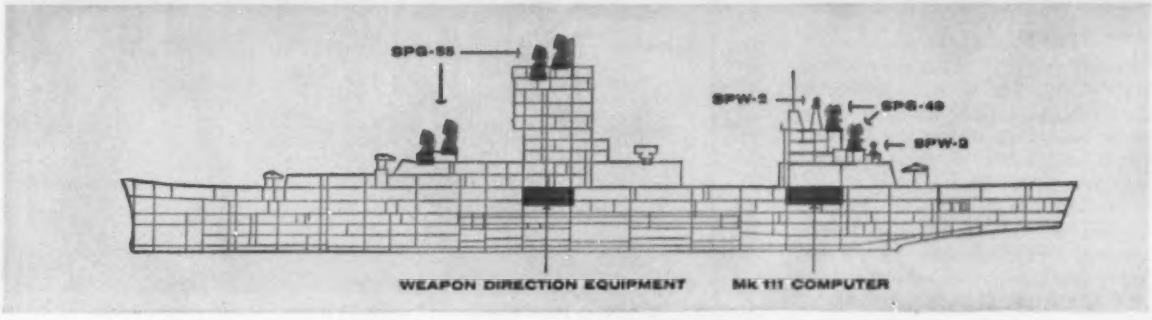
Power from the engines is transmitted through right angle gear boxes to a combining gear box and then, by shafting, to the forward and aft transmissions. Interchangeable engine gear boxes are mounted on the front flange of the engine and contain overrunning clutches to provide independent engine operation. They can be installed or removed while the engines are on or off the helicopter. In replacing a complete engine package only two transmission oil lines must be disconnected.

Combining gear box is located in the aft fuselage; it also has a dry sump lubrication system. It contains the disk-type rotor brake and a rotor dephasing device. Forward transmission is mounted on four mounting lugs of the forged aluminum cover which transmits

CABIN of the YHC-1B is 78 in. high. Width is 90 in. Length, from ramp hinge-line to forward bulkhead, is 30 ft. Constant cross-section fuselage can be easily lengthened.

SUPPORT structure of the Chinook will mount 24 litters. Cabin accommodates 32 troops plus the troop commander in the jump seat, or 27 paratroops. The rear loading ramp can be left opened, partially opened, or can be removed for flight, facilitating free-drop delivery. Cockpit includes dual controls and "T" formation instrumentation.

...aboard the Navy's first nuclear-powered cruiser, the Long Beach



Fire Control by SPERRY

When the Navy's first nuclear-powered surface ship—the USS LONG BEACH—joins the fleet, she will have a cruise capability of better than 30 knots, with virtually unlimited range, and she will be armed with the surface-to-air Talos and Terrier missiles. The most advanced ship of her kind, the "CGN-9" will have the most advanced shipboard missile control equipment: Sperry.

Forward, Sperry SPG-55 missile-guidance radar directs the Terrier missile. Aft, Sperry SPG-49 super-radar controls the longer range Talos missile. Amidships, and in the protected below deck region, are the brains of the systems, the computer complex. The Sperry Weapon Direction Equipment (WDE) evaluates target threat and decides which missile to fire at the selected target. The Sperry Mk 111 computer reads target position data from the SPG-49, calculates the best missile-to-target flight path, and positions the guidance beam generated by the Sperry SPW-2 Radar. Then it evaluates "kills."

With her combination of speed, range, firepower, and advanced Sperry fire control and navigation equipment, the LONG BEACH will make a formidable argument for peace when she joins the fleet.

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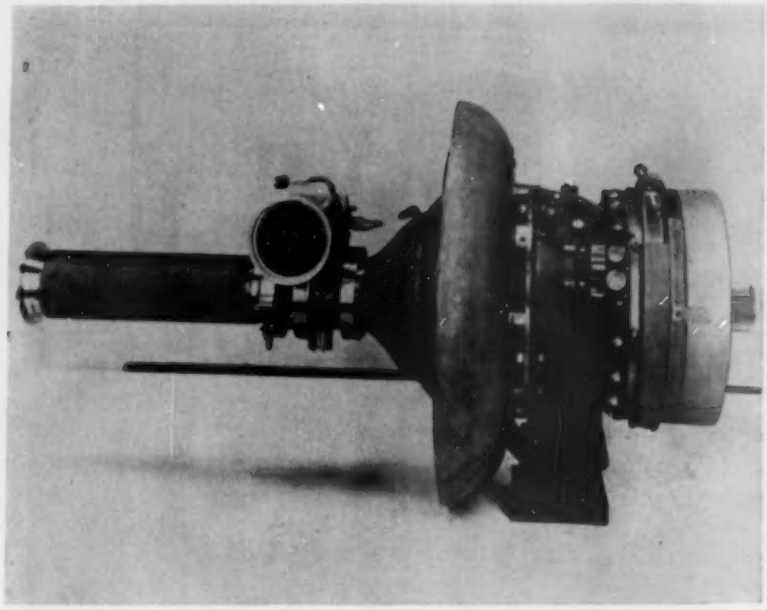

General Electric Designs Nuclear Engine Starter

First photo of a 500 hp., 150-lb. combination starter and motoring unit developed for an aircraft nuclear powerplant by General Electric's Aircraft Accessory Turbine Department. Pneumatic-powered unit brings turbomachinery to self-sustaining speed in 1 min. and keeps it turning over (motoring) during powerplant cooling period at shutdown.

all the forward rotor loads to the structure.

The aft transmission is mounted on four mounting lugs of the upper transmission cover. The aft pylon bearing is oil (pressure) lubricated, not greased.

Drive Shafting

Drive shafting is composed of interchangeable sections of aluminum tubing connected by laminated, flexible, stainless steel couplings and is supported by grease lubricated ball bearings isolated from the airframe structure. Forward and aft transmissions have a wet sump oil system with an operating pressure of 60 psi. Combining gear box and engine gear boxes have a complete and independent oil circulation system.

Fuel system consists of two open vent fuel tanks located in external pods attached to the fuselage side. Total fuel capacity is 630 gal. Tanks are gravity filled at 200 gpm. and ground defueled at 30 gpm. System can be operated up to 6,000 ft. without boost pumps. Fuel can be fed to either or both engines from either or both tanks.

Auxiliary power unit is a gas turbine engine developing 55 hp. at sea level temperature of 125 ft. Dry weight is 60 lb. A 3,000 psi. hydraulic motor/pump, driven directly from the power take-off, provides hydraulic power for APU starting, main engine starting and accessory gearbox drive for equipment checkout with engines and rotor shut down. YHC-1B rotor blades have a radius of 29.5 ft. and a total blade chord of 23 in.

Airfoil is a modified NACA0012. The blade has a 9 deg. twist and a solidity ratio of 0.607 of the rotor disk. Blade is attached to the hub at the vertical hinge by a vertical-hinge pin. The pin is taper fitted with the blade socket which threads onto the root end of the blade.

The blade damper attachment is an integral part of the socket.

Chemical deicing system is incorporated into the blade. The centrifugal force of the rotating blade draws a mist of air, glycerine and alcohol from a slinger ring mounted around the rotor shaft.

Rotor Head

The rotor head is a fully articulated assembly containing horizontal, vertical and pitch hinges, which allow each blade to flap, lead-lag and pitch (feather). The flapping hinges are inboard at the rotor shaft and the lead-lag hinges are outboard at the blade root end. Pitch hinges are located between these two points.

A self-contained hydraulic damping system for limiting the lead-lag motion is connected to the trailing edge of the blade span and the pitch housing. All rotor bearings are completely submerged in oil at all times.

Only four of the six blades require folding. Manual folding is accom-

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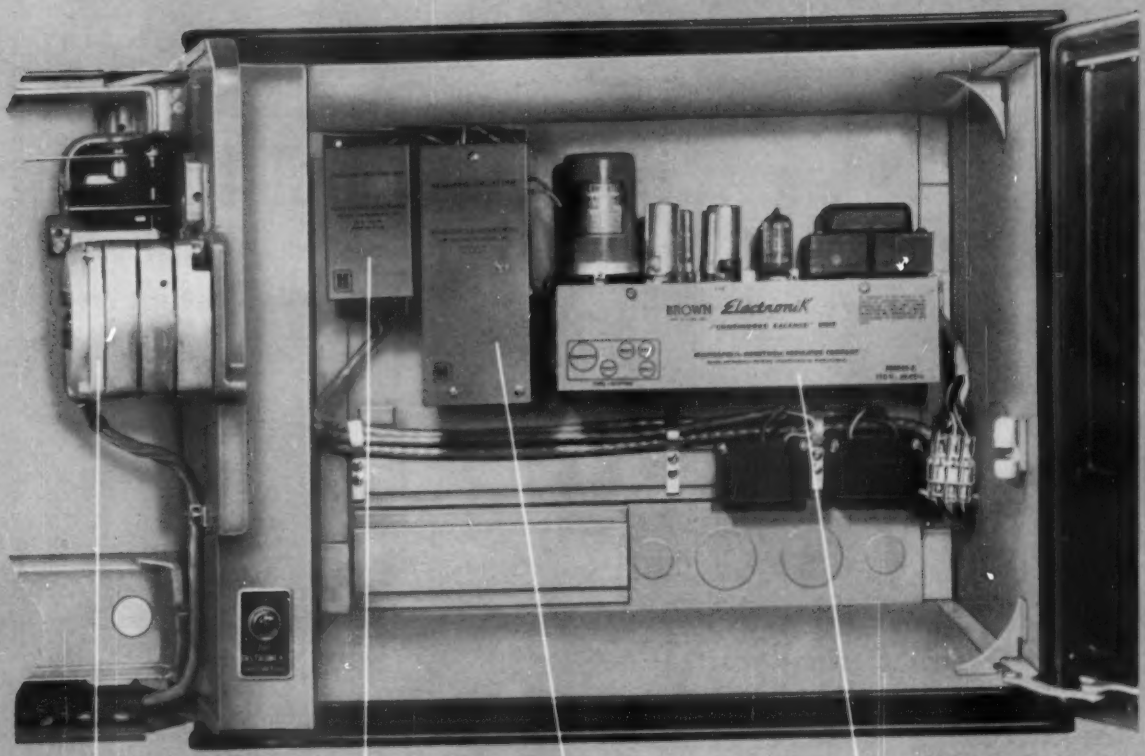
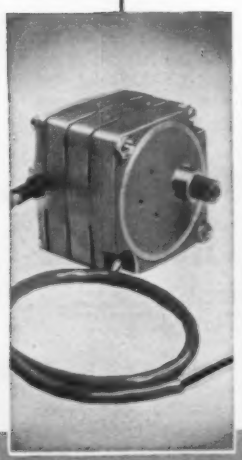
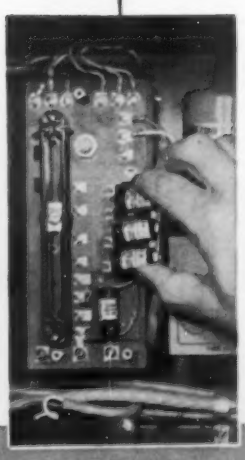


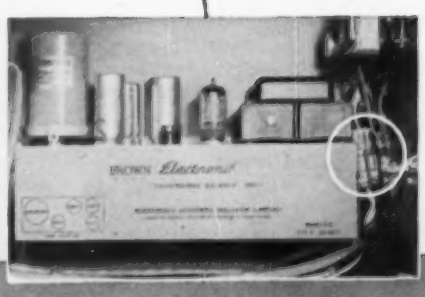


Servo Motor has sectional housing, leakproof oil wick, printed circuits for simplified servicing. Any major part can be replaced in 2 minutes.

Constant Voltage Module —Uses Zener diodes and an ambient temperature compensator to replace standardizing mechanism.



Measuring Circuit Module—Contains easily-changed range spool panels and vernier adjustment. Range is changed simply by replacing screw-clip panels of fixed resistors.



Amplifier Module—Quick-connect design permits fast, easy removal for servicing and replacement. Circle shows quick connect plug.

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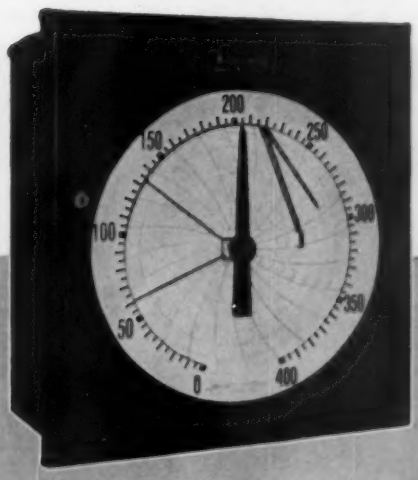

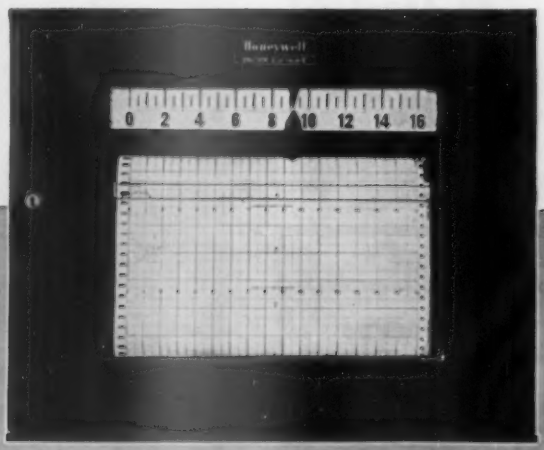

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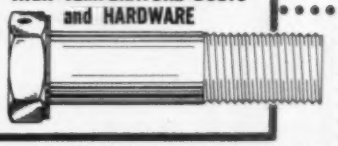

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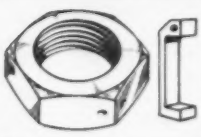

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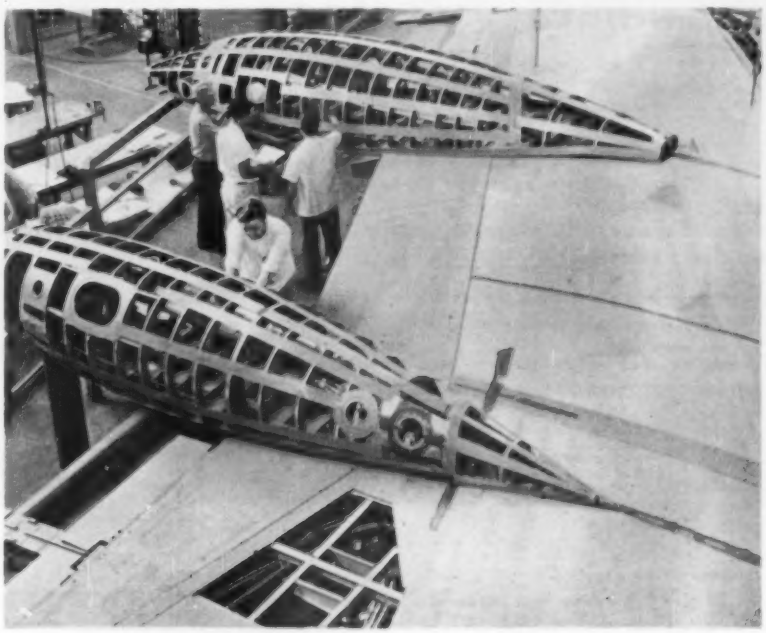
plished by dephasing the rotors, inserting pitch lock pins, and unlatching the blade dampers with a built-in, quick-release mechanism. All folded blades are within the maximum width of the fuselage.

A hydraulically-actuated external cargo hook, capable of suspending eight tons, is furnished at the rescue hatch. It can be controlled either by the pilot or a man at the hatch. The hook is mounted on a carriage and travels laterally on a curved beam so that the line of action intersects the centerline of the helicopter slightly below its center of gravity, thus providing maximum lateral stability and minimizing the rolling movement created by a swaying load.

Cargo handling and rescue hoist system evolves around a utility winch designed to produce 3,000 lb. cable pull at 20 fpm. for cargo loading, or 600 lb. cable pull at 100 fpm. for rescue operations.

Winch is powered by a hydraulic motor and incorporates a limiting de-



Convair 600 Anti-Shock Bodies, Slats Detailed

Aerodynamic anti-shock bodies for Convair 600 jet transport wings (AW Feb. 8, p. 41) are shown in mockup form (above). Two are attached to upper surface of each wing to straighten airflow and cut drag. Inboard bodies are 22 ft. 10 in. long and 40 in. wide; each holds 300 gal. of fuel and outboards hold 218 gal. Below, workman adjusts one of the 600's leading edge slats, shown in the extended position. The plane has four slats.

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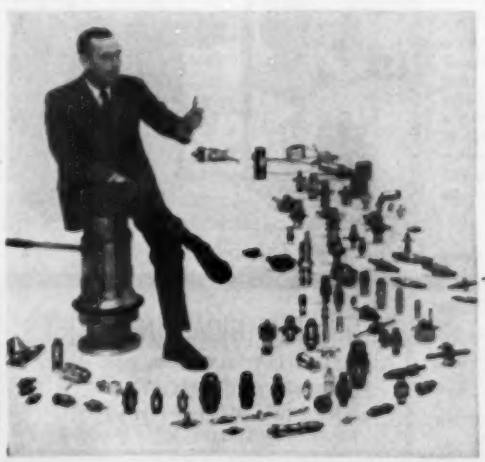

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TITLE_____

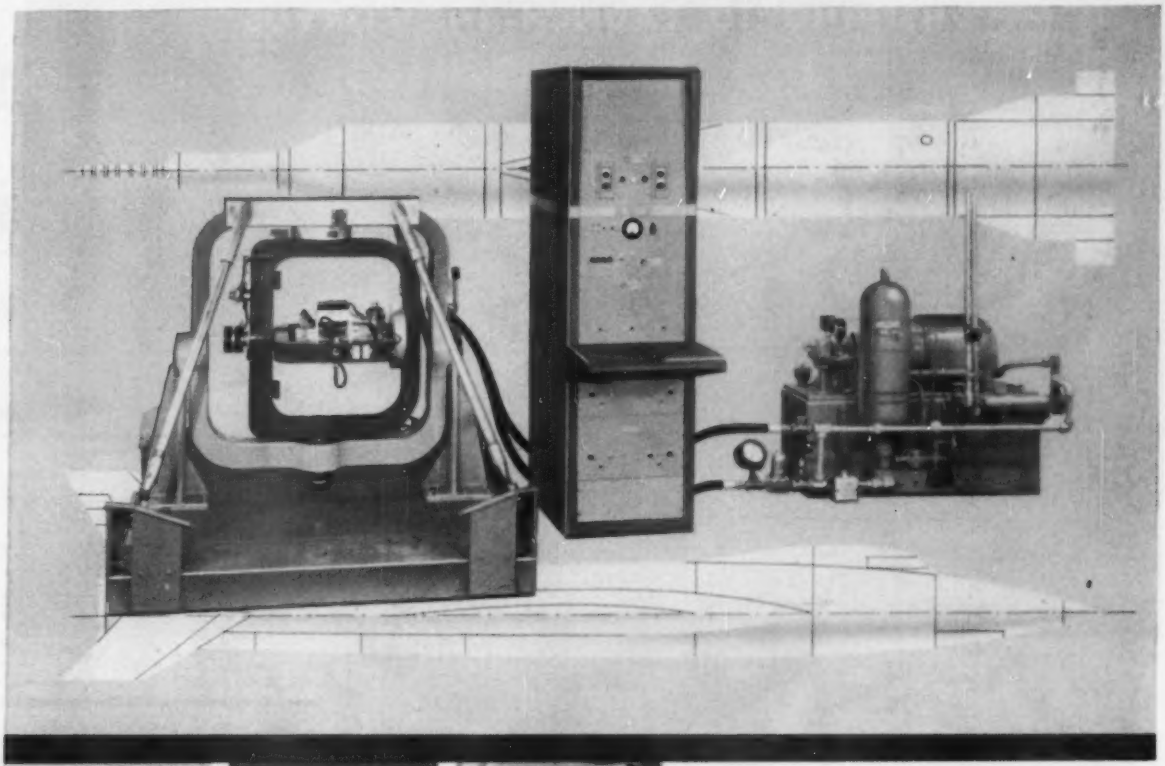
COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

THREE-AXIS FLIGHT SIMULATION

assures sytem accuracy and stability



Direct hydraulic drive, free from gear noise, produces exceedingly smooth motion from rates as low as the earth's rotation to velocities and accelerations considerably higher than those encountered in modern, high-performance aircraft and missiles.

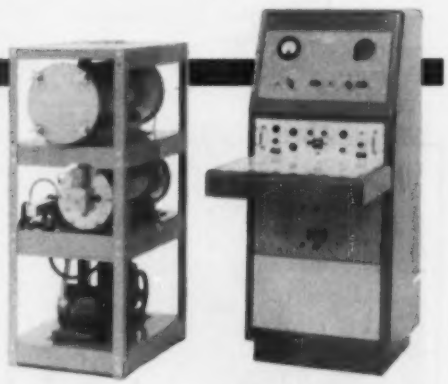
By creating the same dynamic motions met in high-performance aircraft and missiles, the CTI Three-Axis Flight Simulator enables accurate analyses of flight control systems and inertial guidance platforms to be made in the laboratory.

Any conventional analog computer can be used with the Flight Simulator for combined programming and system analysis. Computer (or other signal source) voltages representing a pre-determined flight path are accurately translated into roll, pitch, and yaw positions, velocities, and accelerations by means of a position-feedback servo system. Superior performance with large-volume, high-inertia loads is achieved at minimum cost and maintenance by the unusual simplicity of design.

Only the use of actual control components under identical flight-motion conditions can enable a laboratory evaluation to assure flight performance. Write for complete technical specifications.

DYNAMIC ALTITUDE SIMULATOR

Available separately or as a companion unit to the Three-Axis Flight Simulator, this Altitude Simulator reproduces dynamic altitude changes through a bandwidth of ±700 feet with a frequency response of 10 cps. Operating range is sea level to 80,000 feet.



Engineers: Career opportunities are currently available at CTI.

CTI®

CALIFORNIA TECHNICAL INDUSTRIES

DIVISION OF TEXTRON INC.

BELMONT 6, CALIFORNIA

Foremost in Automatic Testing

vice which stops the winch before a snagged load can break the cable.

For rescue operations the cable is reeved upward just aft of cockpit, taken along the ceiling to the rescue hatch, then lowered down through the hatch. Pulley block directly over the hatch is equipped with a cable cutter for emergency operations.

To hold cabin noise level from 82 to 106 db. in a frequency range of 9,600 to 37.5 cps. a sound barrier is installed in the ceiling area. This is composed of a layer of samping tape, a metal ceiling, and glass fiber batting placed between the ceiling and outside skin.

An internal combustion heater, which need not depend on engines operating, supplies the 200,000 Btu. per hour needed to maintain a minimum of 40F at −25F ambient conditions. To ensure fresh air at a rate of at least 20 cfm. per occupant, a blower output of 850 cfm. is used.

Flight Controls

Flight control system of the YHC-1B is composed of two power boost systems, two electronic stabilization systems, and a linkage system which kinematically mixes and transmits control motions from the cockpit to the rotor heads.

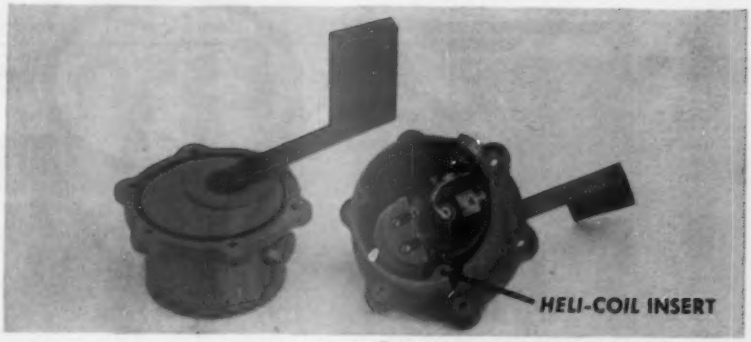
The flight control system is a dual reliability system powered by two hydraulic actuators located immediately below each swashplate. The failure of one will not effect pilot's controls or aircraft stability. All components of the control system are accessible for servicing via access panels and doors.

The two flight control hydraulic systems are Type I, 3,000 psi. systems with a maximum flow of 5.5 gal./min. Each system has its own accumulator, reservoir and pump. One system powers the upper dual actuators in each rotor head and the stick boost actuators. The other system powers the remaining upper dual actuators and the stability augmentation system extensible links. Failure of one system will not cause excessive cockpit control loads.

Hydraulic System

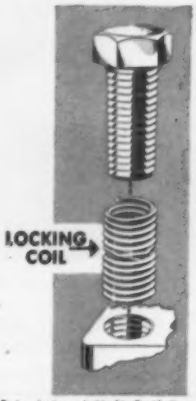
The utility hydraulic system powers the wheel and rotor brakes, the rescue and loading winch and hook, the cargo ramp, and also provides power for main engine, auxiliary power and starting.

Primary electrical power is generated by two 20 kva., 400-cycle, self-cooled, alternating current generators mounted on the accessory gear box. System is a.c., with major components located in the right-hand pod. Secondary electrical power is furnished by two alternating current-to-direct current converters rated at 28 v., 200 amp. each. Major components of the d.c. system are located in the left-hand pod.



Heli-Coil® Screw-Lock Inserts lock screws against impact and vibration and permanently protect critical tapped holes in this transducer assembly.*

Critical Electronic Controls Get internal-Locking, Protective Threads with HELI-COIL Screw-Lock Inserts



Principle of Heli-Coil Screw-LOCK Insert. Locking center coil grips internally, holds screw firmly

Electronic control devices for aircraft and missiles, like this angle of attack vane transducer made by U. S. SCIENCE CORPORATION, LOS ANGELES, CALIF., have to withstand severe vibration, impact, corrosion and temperature change. They must be made of light materials and still have strong threads -- able to hold fasteners tightly and stand frequent assembly and disassembly.

U. S. SCIENCE insures rock-solid screw assemblies by protecting vital tapped holes with one-piece *internal-locking* ***Heli-Coil*** Screw-LOCK Inserts. These precision formed, stainless steel wire inserts eliminate thread wear, lock screws securely — without resort to clumsy, external lock nuts and lock wiring.

Simple Installation Procedure

U. S. SCIENCE finds it easy to install ***Heli-Coil*** Screw-LOCK Inserts. Drilled holes are tapped with a ***Heli-Coil*** tap and the Inserts wound in with a prewinder inserting tool. Conventional screws are used in assembling the unit.

Heli-Coil Screw-LOCK Inserts

- positively lock fasteners against loosening under impact and vibration
- prevent thread wear, stripping, corrosion, galling and seizing
- eliminate lock nuts, lock wiring, other supplementary locking devices
- permit repeated disassembly and reassembly
- can be used in standard proportion bosses without need for redesign
- save assembly time, space, weight and cost
- meet government specs for locking torque and vibration

*Patented

HELI-COIL CORPORATION
DANBURY, CONNECTICUT

HELI-COIL CORPORATION, *202 Shelter Rock Lane, Danbury, Connecticut*
Send complete design data on *Heli-Coil* Screw-LOCK Inserts

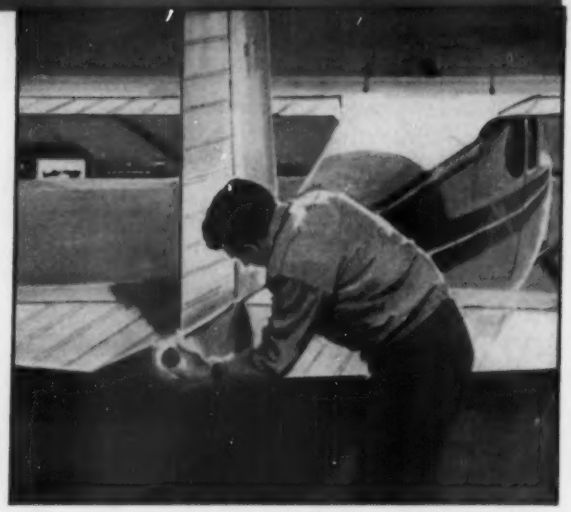
NAME_____ TITLE_____
FIRM_____
ADDRESS_____
CITY_____ ZONE____ STATE_____

In Canada: Armstrong Beverley Engineering Ltd., 6975 Jeanne Mance St., Montreal 15, Que.

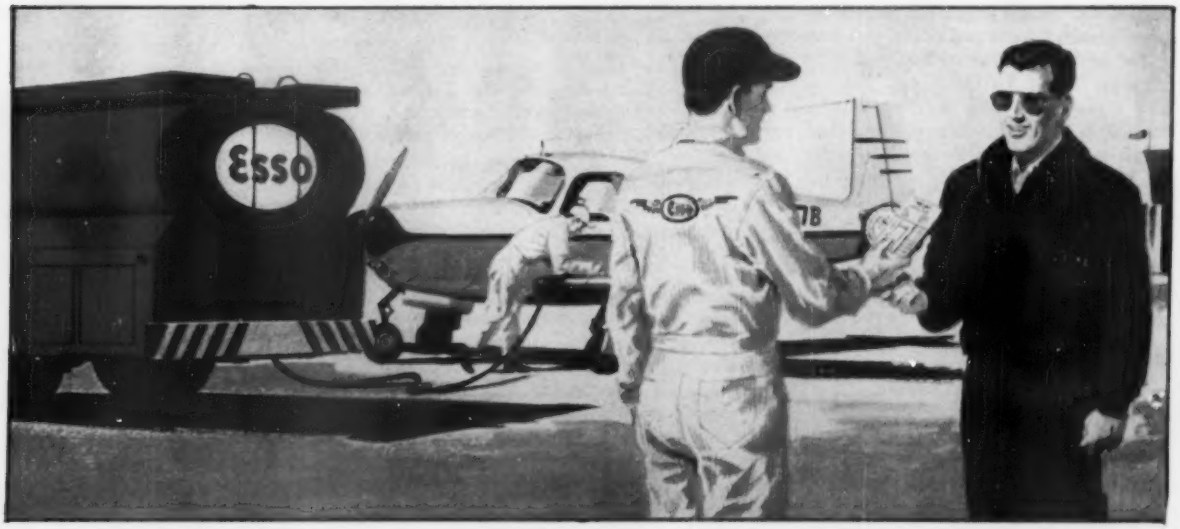
ESSO

WING TIPS

DON'T BE A CLOUD SKIPPER — Flying too close to Old Man Cumulus is inviting mid-air collision. If another plane breaks through the clouds, chances are its pilot won't see you in time. Bear in mind that the legal "thousand on top" leaves you very little leeway – particularly in jet territory.



TAKE 5 — Although checking lights before night flights is SOP, many pilots fail to take the 5 seconds necessary to check their tail light. Running into old friends is fine, but not while flying. So take 5 – and stay alive.



YOUR ESSO AVIATION DEALER—This is the man who's always ready to help assure your flying safety. He carries a complete line of dependable Esso fuels and lubricants that work hard for your engine "upstairs" where it counts. He can also provide you with Flight Calculators and Flight Plan Sequence Cards—free, of course—to make your cross-country trips easier and more fun. And remember, your Esso Credit Card is a convenient way to charge fuel, oil, lubrication, minor repairs, and landing fees at selected airports from coast to coast, and Canada too.

Highways or Skyways..."ESSO RESEARCH works wonders with oil"

FINANCIAL

Investment Company Disposes Of Trunkline Stocks, Buys Aircrafts

New York—Analysis of American trunk airlines' financial future by National Aviation Corp., a closed-end investment trust with net assets of $26,418,016.55 in 1959, is coupled with a decision to dispose of more than 90,000 shares of stock representing ownership in eight major U.S. carriers.

At the same time, the company, according to its annual report to stockholders last week, was expanding its holdings of stock in old-line aircraft manufacturing concerns.

National Aviation contends that the domestic trunk system "is in a strait jacket that promises to strangle it."

Contributing Factors

To support its conclusion, the investment house cites these contributing factors:

• **Too many airlines.** Opinion of National Aviation is that the 12 domestic trunks could "conceivably" be reduced to six if the combination was accompanied by an overhaul of present route structures.

• **Too many planes operating** and on order. This will hold true for the foreseeable future because of "competitive compulsions" that have carried over from a piston-engine route era, according to the report.

• **Dilemma on fixing fares.** According to National Aviation, the levels expected to flow from the four-year-old General Passenger Fare Investigation either will be too high "to broaden the air travel market as rapidly as it must be" to fill projected fleets, or "too low to produce sufficient earnings in a less dynamic market."

• **Decreasing effect** of government subsidies. Because of the "temper of the times," resort to subsidy by a domestic trunk would be at best an interim arrangement until a way were found to remove such carrier from the competitive scene.

• **Relatively minor role** for air freight. "Untenable" is the way National Aviation describes the hopes of several carriers that their passenger operations will be backstopped by an efficiency breakthrough in the hauling of cargo.

Turning to the international passenger market, the investment house again singled out multiple competition as the reason for dwindling profits in a time of rising revenues. This competition, of which only a fraction is furnished by U.S. carriers, stems from foreign airlines "all of them predominantly government-owned or controlled and backed by fierce national pride."

Local service airlines, not represented in National Aviation's portfolio, are nonetheless valuable because of their feeder function within the over-all airline system. Because of this, the firm recommends that present federal subsidies, which prevail despite a 33% increase in local service airline revenue in 1959 over 1958, be continued in the hope that the small carriers ultimately can become self-sufficient.

National Aviation's analysis of the airlines' financial outlook was reflected this fall and winter by stock prices, with many issues falling 10 to 15 points from their summer highs in what analysts generally attributed to be a reaction to the burst of optimism with which the public greeted introduction of jet transports. A movement away from airlines was also seen in National Aviation's portfolio from which substantial blocks of American, Braniff, Delta, Eastern, Northwest, Pan American, United and Western airline stocks were sold.

Aircraft Holdings

Concurrently, the investment company was buying the issues of such concerns as Boeing Airplane Co. (12,450 shares), Grumman Aircraft Engineering Corp. (10,000 shares), Lockheed Aircraft Corp. (11,500 shares), Northrop Corp. (14,500 shares), and Douglas Aircraft Co. (4,850 shares).

It also increased its holdings by 7,260 shares in Electronic Associates, Inc., by 6,500 shares in Thompson Ramo Wooldridge, Inc., and by 1,700 shares in Piper Aircraft Corp.

The instance of Chance Vought Aircraft, Inc., which last year lost its role as prime contractor for Navy's canceled Crusader fighter and for the Regulus II missile, was an exception to National Aviation Corp.'s movement toward manufacturing issues; the investment house sold its total Chance Vought holdings of 10,000 shares.

Appearing on Feb. 4, Standard & Poor's latest survey of the air transport industry was somewhat more optimistic. It termed the trunklines' outlook "obscure."

After predicting good revenue gains in 1960, Standard & Poor said that the likelihood of profits to match was "less promising" because of heavy introduc-

BASIC BUILDING BLOCKS FROM KEARFOTT

VERTICAL GYRO

Kearfott's rugged new vertical gyro, designed for missile application, is a two-degree-of-freedom instrument with 360° of freedom about inner gimbal axis. Self-contained vertical erection system incorporates liquid bubble-type vertical sensing device.

TYPICAL CHARACTERISTICS #B2115

Environmental Capabilities
Vibration:
5 g, 20-1000 cps;
10 g, 1000-2000 cps
Temperature Range (operative):
—54°C to +71°C
(non-operative):
—65°C to +85°C
Altitude: Unlimited

Pickoffs
Excitation:
26V, 400 cps, single phase
Error from E.Z.: 10 min. max.
Output Voltage (line to line):
11.8V ± 5% max.

Motor
Excitation:
115V, 400 cps, three phase
Power: Starting: 35 watts
Running: 7.5 watts

Performance Characteristics
Repeatability of Established Vertical:
To within a cone of half angle equal to 12 minutes of arc
Scorsby Drift Rate in 5 Min. Time:
0.3°/min. (average)
Erection Rate:
Normal: Between 2° and 4°/min.
Fast: 80°/min. intermittent, 40°/min. continuous

Physical Features
Anisoelastic Drift:
0.08°/min/g² at resonance
Weight: 5.5 lbs. (approx.)
Mass Unbalance: 0.1°/min/g

Write for complete data.

KEARFOTT DIVISION
GENERAL PRECISION INC.
LITTLE FALLS, NEW JERSEY

We produce results!

AERONCA

designs—tools—produces complex brazed stainless honeycomb structures

There is much talk in the industry about state-of-the-art capability in stainless honeycomb sandwich fabrication. Actual *production experience* in this new field of exotic materials and structures still is limited to a relatively few companies. *And Aeronca is one of them.*

At Aeronca, we have fully integrated design, tooling and production facilities in operation today. A pioneer in stainless honeycomb development, Aeronca has acquired advanced technological knowledge from proprietary R&D programs and production of components for operational air weapon systems.

The supersonic speed brake assembly illustrated below is an example of our capability. This design, one of the most intricate brazed stainless structures produced to date, is 75" long, 46½" wide and 3½" deep. Its complex cross-section required extremely precise forming and machining as well as special tooling and process control.

Whatever your honeycomb requirements, you can save time, expense and headaches by utilizing our extensive experience and facilities. Our customers will verify that *Aeronca produces results . . . not claims!*

This 130° curved section is typical missile structure.

Stainless honeycomb components for B-58 "Hustler".

Top view of new speed brake assembly.

Operational expansion has created openings for additional senior engineers. Write to W. W. Gardiner, Personnel Manager.

AERONCA

aeronca manufacturing corporation

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tion costs on new jets, rising depreciation charges and carrier capacity gains greater than forecast increases in traffic. Capacity surplus, the survey said, would result despite a traffic jump of about 10%.

Standard & Poor noted that this was a lesser rate of growth than 1959's estimated figure of 14%. It attributed the slackening to the fact that in 1959 the trunklines "compressed" two years of growth into one after a general business recession and series of strikes had paralyzed the industry during 1958.

For the first three quarters of 1959, Standard & Poor statistics showed a sharp rise in the depreciation charges of the four largest trunk carriers—American, United, Eastern and Trans World Airlines—reflecting the phase-out of piston equipment. Total depreciation of American in 1958 was listed as $14,610,322. Comparable figure for the nine months ending Sept. 30, 1959, was $22,149,490.

New Offerings

General Devices, Inc., Monmouth Junction, N. J., primarily engaged in the development and manufacture of a related line of electronic and electromechanical components and systems for multiplex telemetering. Offering is 60,888 shares of common stock, for subscription by common stockholders at the rate of one new share for each five shares held; also, an additional 10,000 shares to be offered to company employes under the company's Employes' Stock Purchasing Plan. Of the proceeds, $380,000 will be used to finance the purchase of land adjacent to the company's present plant, the construction of an addition to the present plant, and the purchase of new equipment therefor; $200,000 will be used to reduce short-term loans; balance will be used for working capital.

Acquisitions And Mergers

Giannini Scientific Corp., New York, has acquired Flight Research, Inc., Richmond, Va., designer and manufacturer of photographic instrumentation equipment. Giannini, a privately owned company, has two other subsidiaries—Plasmadyne Corp., Santa Ana, Calif., and Plasmakote Corp., Culver City.

Jerrold Electronics Corp., manufacturer of closed circuit television systems, reports substantial interests in its stock have been acquired by John L. Loeb, senior partner in Carl M. Loeb, Rhoades & Co., investment bankers, New York, and Jack Wrather, head of Jack Wrather Organization (oil and entertainment fields) Beverly Hills, Calif. Jerrold's President Milton J. Shapp, and his wife, will sell 322,000 of their 644,025 shares in Jerrold to Loeb and have granted Weather options to purchase an additional 222,000 shares. Jerrold has 1,269,500 common shares outstanding.

Chicago Aerial Industries, Inc., acquired Pacific Optical Corp. by giving up 19,000 shares of CAI stock and assuming a Pacific Optical note for $132,000. Pacific Optical, producer of optical and infrared systems and components, will operate as a separate division. CAI manufactures precision avionic equipment; Pacific Optical produces data displays, reconnaissance and guidance systems.

Beckman Instruments, Inc., has acquired the assets of Harold Kruger Instruments of San Gabriel, Calif., and Tool-Lab, Inc., of Escondido, Calif., for an initial cash investment of $130,000. Kruger makes chemical analysis equipment, metering pumps and Teflon connectors. Tool-Lab produces precision electric meters. Beckman manufactures analytical instruments, potentiometers, servomotors and power-monitoring equipment.

Gorham Manufacturing Co.'s board of directors has approved terms of acquisition of all assets of Pickard & Burns, Needham, Mass., maker of electronic navigation, communications, radar and instrumentation. Gorham, of Providence, R. I., produces microwave components, in addition to its silversmith business.

Shareholders of Robinson Technical Products, Inc., Teterboro, N. J., approved acquisition of Kensico Tube Co., Mt. Kisco, N. Y., producer of copper pipe and tubing, some of which is used in instrumentation. Each share of Kensico common stock will be converted into five common shares of Robinson. Kensico will be operated as a division of Robinson and will be headed by Thomas Nast, Kensico president.

Stockholders of Electrosnap Corp. and Controls Company of America voted to approve a merger of the companies. Each five shares of Electrosnap common stock will be converted into six shares of Controls Company of America common, resulting in issuance of 110,400 shares of Controls stock. Electrosnap is a Chicago manufacturer of precision switches; Controls Company of America, Schiller Park, Ill., makes automatic controls.

Atlantic Research Corp. Alexandria, has acquired Desomatic Products, Inc.,

BASIC BUILDING BLOCKS FROM KEARFOTT

DIRECTIONAL GYRO

This compact new gyro, designed for application in high-performance aircraft and missiles, provides extremely accurate attitude data. Its liquid bubble-type vertical sensing element generates error signals proportional to spin axis displacement from horizontal, while minor wiring modifications permit sensor connection to leveling torquer, completing inner axis leveling loop.

TYPICAL CHARACTERISTICS #A2215

Environmental Capabilities
Vibration:
5g, 20-1000 cps; 10g, 1000-2000 cps
Temperature Range (operative):
—54°C to +71°C
(non-operative):
—65°C to +85°C
Altitude: Unlimited

Azimuth Pickoff
Excitation:
26V, 400 cps, single phase
Output (sinusoidal):
11.8V ± 5% max.
Error from E.Z.: 10 min. max.

Motor
Excitation:
115V, 400 cps, three phase
Speed: 23,500 RPM
Power: Starting: 35 watts
Running: 7.5 watts

Performance Characteristics
Drift: 4°/hr. max.
Leveling Rate:
Between 2° and 4°/min.
Azimuth Torquing Rate:
360°/min. (intermittent)
40°/min. (continuous)

Write for complete data.

KEARFOTT DIVISION
GENERAL PRECISION INC.
LITTLE FALLS, NEW JERSEY

READY IS THE RAVEN'S MOST FAMOUS TRAIT

And the record proves it. Here are some indications of the reliability of this remarkable light helicopter from the U.S. Army's top flight training operation at Camp Wolters, Texas.

1 At this Army-Southern Airways Co. contract operation, the H-23D Raven is the first helicopter ever approved by the Military for 1,000 flight hours between major overhauls... on all major components of its drive system.

2 The D ranks highest of all Army rotorcraft in air availability... lowest in maintenance cost.

3 Regardless of weather or any other delays, efficient Camp Wolters joint military and civilian management puts its fleet of Ravens through more than 7,000 actual training hours every month.

Designs are one thing. Deliveries another. Both come from

HILLER AIRCRAFT CORPORATION

PALO ALTO, CALIFORNIA WASHINGTON, D.C.

ADHESIVE ENGINEERING DIVISION, SAN CARLOS, CALIFORNIA

Falls Church, Va., as a wholly-owned subsidiary. Desomatic, which engineers and manufactures products, including dehumidifiers, for the gas processing field, employs about 50 persons. It will continue to operate under existing policies and technical management. Administrative responsibility for Desomatic will be assumed by Presson S. Shane, head of Atlantic Research's Solid Propellant Division. The acquisition involved an exchange of Atlantic Research stock for Desomatic stock owned by the Desomatic management group. Atlantic Research recently acquired Jansky & Bailey, Inc., Washington, D.C.; Prewitt Aircraft Co., Phila., and A. M. Martin Co., Pasadena, Calif.

Financial Briefs

Telecomputing Corp., Los Angeles, reports record net earnings of $1,917,852 on record sales of $38,333,154 for the fiscal year ended Nov. 1, compared with Fiscal 1958 net earnings of $343,677 on sales of $29,490,049. Per-share earnings in Fiscal 1959 were 71 cents on an average of 2,672,000 common shares, compared with 12 cents on an average of 2,554,111 common shares outstanding in the previous year. Company's backlog was $27,735,000 on Nov. 1, compared with $22,338,000 on Nov. 2, 1958.

Altamil Corp., El Segundo, Calif., net sales for the first fiscal quarter ended Nov. 30 were $2,937,779, compared with $1,463,970 for the corresponding period in Fiscal 1958. Net profit for the Fiscal 1959 quarter was $56,799; the company recorded a net loss of $173,604 in the corresponding Fiscal 1958 quarter.

Varian Associates reported record sales of $10,677,551 for the first quarter ended Jan. 2, up 30% from sales of $8,197,798 recorded in the first Fiscal 1959 quarter. Net income for the first Fiscal 1960 quarter was $755,710 or 24 cents a share on 3,130,482 shares outstanding, compared with $524,470 or 17 cents a share on 3,111,132 shares for the corresponding period last year. Backlog on Jan. 2 was $25,188,000; it was $19,815,000 a year earlier.

Moog Servocontrols, Inc., sales for the calendar year 1959 totaled $11,201,000, compared with sales of $8,692,000 for Calendar 1958.

Aerojet-General Corp., a subsidiary of General Tire & Rubber Co., reports sales for the fiscal year ended Nov. 30 totaled $364,401,200, or 67% more than Fiscal 1958 sales of $218,375,281. Earnings after taxes for Fiscal 1959 were $8,203,323; they were $6,027,827 at the end of the previous fiscal year.

American Research and Development Corp., venture capital company of Boston, will ask stockholders to approve, at an annual meeting Mar. 2, a proposal to increase authorized shares and then effect a three-for-one split of authorized shares. Company's net assets on Dec. 31, after deducting a distribution of $1.30 a share, were $23,459,278, or $59.39 a share on 395,000 shares outstanding. Net assets were $14,795,999 at the end of 1958.

Chance Vought Aircraft has signed an agreement to acquire an 80% interest in Information Systems, Inc., Skokie, Ill., expanding the firm's holdings in the automation field. In turn, Information Systems is acquiring operating assets of Panellit, Inc., originally its parent company. Genesys Corp., wholly-owned Chance Vought subsidiary, and Panellit will become separate operating units of Information Systems, which will be a separate subsidiary from Chance Vought's new mobile homes subsidiary, Vought Industries, Inc. (AW Feb. 1, p. 27).

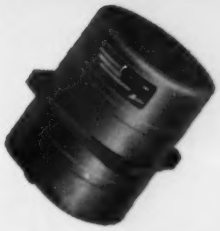
North American Aviation earnings for the first quarter of Fiscal 1961 were $5,992,000 (74 cents per share), an increase of $91,000 and a cent per share over a like period a year ago. Quarter sales totaled $260,668,559, up $39,839,486 over sales a year ago. Company backlog is $678,370,635, against $622 million for last year's opening quarter.

Barden Corp., Danbury, Conn., maker of precision ball bearings, reported record net earnings of $1,215,192 or $1.69 a share on 718,033 shares for 1959, compared with net earnings of $649,419 or 90 cents a share on the same number of shares in Fiscal 1958. Sales in Fiscal 1959 were a record $12,111,943 compared with $8,578,107 in the previous fiscal year. The company recently arranged a private placement of $2 million in 5½% convertible subordinated notes due Dec. 1, 1975, with institutional investors.

Siegler Corp. net income for the half year ended Dec. 31 was $1,758,878 or $1.07 a share on 1,639,602 common shares outstanding, compared with $1,231,661 or 80 cents a share on 1,538,171 shares in the last half of 1958. Sales for the 1959 latter half were $45,059,831; they were $41,167,719 at the end of the last six months of 1958.

Allegheny Ludlum Steel Corp. net earnings for 1959 were $11,290,664 or $2.92 a share on 3,869,654 common shares outstanding, compared with $5,844,803 or $1.52 a share on 3,856,008 shares for 1958. Sales for 1959 were $230,664,649, up 14% from 1958 sales of $201,715,284.

BASIC BUILDING BLOCKS FROM KEARFOTT



FREE GYRO

A highly reliable, two-degree-of-freedom instrument utilizing AC synchro transmitters at each gimbal axis. Designed to operate under the most severe missile conditions, this gyro has AC torquers mounted at each gimbal axis to permit command positioning or slaving of spin axis to desired reference position; each torquer capable of producing a precession rate of 360°/minute with 12.5 watts/phase power input.

TYPICAL CHARACTERISTICS #Q2315

Environmental Capabilities
Temperature Range:
(operative): —54°C to +71°C
(non-operative): —65°C to +85°C
Altitude: Unlimited
Vibration: 10g, 10-2000cps

Pickoffs
Excitation:
26V, 400 cps, single phase
Output (sinusoidal):
11.8V ± 5% max.
Error from E.Z.: 10 min. max.

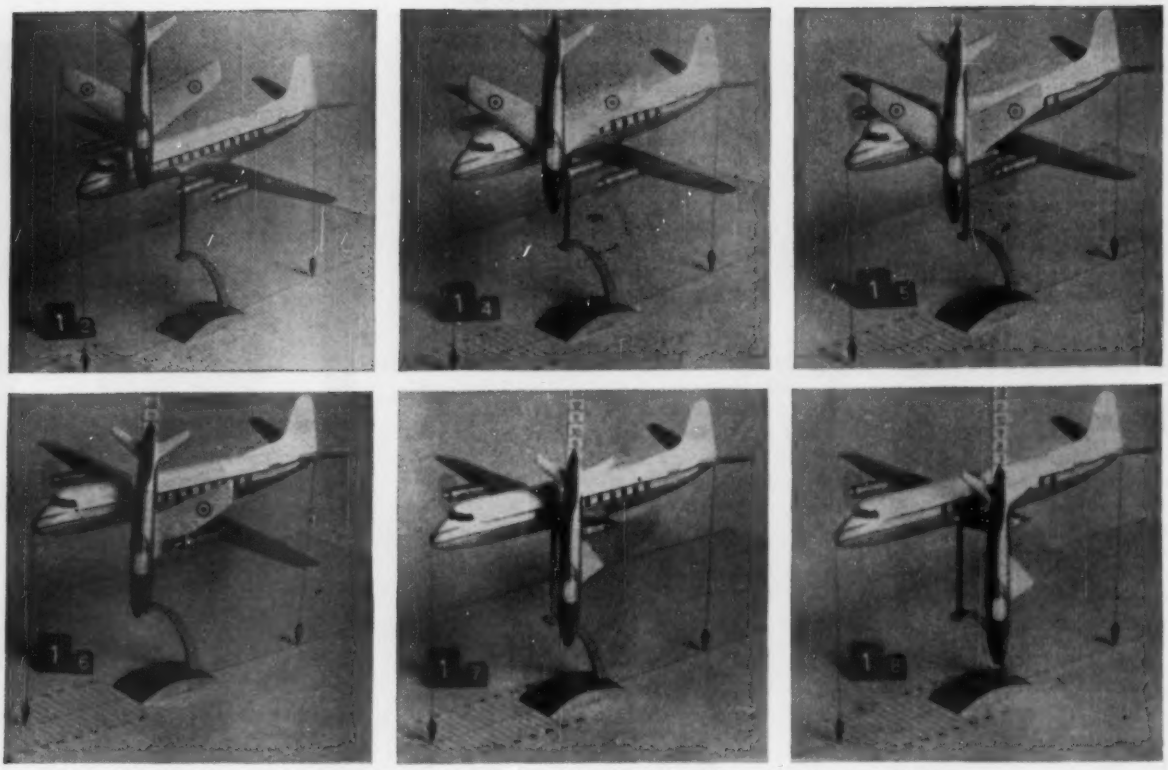
Motor
Excitation:
115V, 400 cps, three phase
Speed: 23,500 RPM
Momentum:
2.25 x 10^6 gm cm^2/sec.

Caging and Preset Provision
(Electrically energized torquer type)
Excitation: 115V max./phase
Torquer Constant:
22.8 dyne cm/$Volt^2$

Performance Characteristics
Free Drift:
5°/minute each axis
Runup Time:
1 minute max.
Torquing Rate:
360°/min. (intermittent)
40°/min. (continuous)

Write for complete data.

KEARFOTT DIVISION
GENERAL PRECISION INC.
LITTLE FALLS, NEW JERSEY



ITALIAN accident investigation board reconstructed the Viscount F-86E midair collision with this model display.

Italian Accident Investigation Report:

BEA Viscount Flew Into Prohibited Area

(Following is a report to the British Ministry of Transport from the Italian Ministry of Defense on an inquiry into a midair collision between British European Airways Viscount 701 G-ANHC and an Italian air force North American F-86E jet fighter, Oct. 22, 1958. The report has been translated from Italian.)

SUMMARY

The Viscount, coming from London and bound for Naples, flying on Amber Airway No. 1, reported at 1144 hr. flight over Ostia at 23,500 ft., stating that it was continuing to Ponza and estimating that it would be over Ponza at 1157 hr.

The collision with an Italian jet fighter aircraft, forming part of a formation on a training flight, occurred at approximately 1150 hr. east of Nettuno. Killed were 26 passengers and five members of the Viscount crew. The fighter pilot parachuted to safety.

The wreckage of the Viscount and of the fighter aircraft was found to the east of Nettuno. The wreckage was scattered mainly over an area extending from the locality C. La Seccia to the sea, over a distance of about 2.7 km. The Viscount wreckage was mainly in the south part of this area and that of the fighter aircraft in the north part.

There was, however, no clear-cut separation between the parts of the two aircraft, nor can a precise law for their distribution be put forward, except for the fact that some of the heavier parts of the Viscount (two propeller turbine engines) were towards the south end of the area.

The turbine of the fighter aircraft, whose trajectory must be considered abnormal, was found in the northwest of the area, a long way from the other parts.

Missing Parts

A large number of parts were not found or not identified or were broken into small fragments. Of the starboard wing of the fighter, only parts of the wing tank, the central aileron hinge and the tip—full of air and still carrying intact the pitot head—and a few other parts were identified. The remainder was reduced to such small and irregularly shaped fragments as would give reason to presume that the wing had exploded.

Again, in respect of the fighter aircraft: of the port wing one part was found which appeared to have been broken off by bending and shear in the same plane. The leading edge was cavitated, presumably as a result of collision with the leading edge of the port wing of the Viscount, between engines No. 1 and 2.

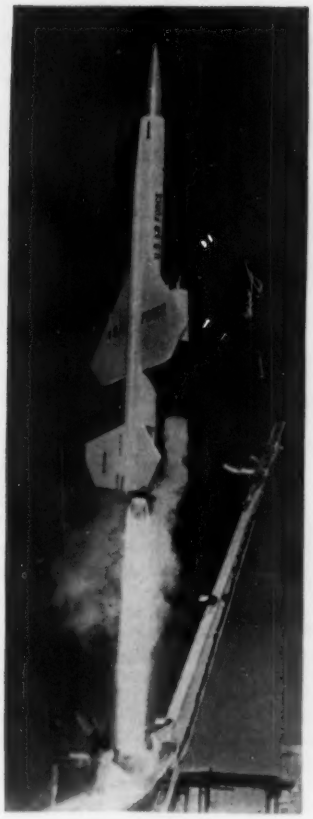
The jet engine was wrecked, its parts were twisted and broken to pieces. The bearings of the main shaft were torn off; the main shaft with the turbine was about 2 km. away from the fuselage. Of the compressor, only a few stator parts and some disks of the rotor were found.

The tail unit was also greatly damaged and without its leading edges. The starboard section of the tailplane had disintegrated and was practically without covering.

The only part of which a fair amount remained was the fuselage from the forward air intake to the jet engine. The pilot's seat had been expelled from the cockpit.

The pilot's seat still had the ejection cartridge intact and unfired. There was a heavy impact on the underside of the bottom of the seat, opposite the underlying center section of the wing, which appeared to have been violently smashed up. The pilot's straps were missing and the corresponding inertia reel; only the right part of the safety belt remained. The left part up to the seat attachment was carried away.

The degree of preservation of the forward part of the fuselage, referred to above, in contrast with the condition of the rear part—obviously reduced to fragments by direct impact—leads to the consideration



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that the fuselage was struck in its rear portion practically at right angles to its axis, and therefore that at the moment of collision the fighter aircraft was in a diving attitude.

As regards the Viscount, almost all the parts were found or identified, except for:

- **Area H** of the port wing.
- **A number of metal sheets** from the left hand side of the top of the forward part of the fuselage (nose), between the door and the cockpit.
- **A great many parts** of propeller turbine engine No. 2.

Of the parts found, the following are worthy of special attention:

- **Engine No. 1** was the part which went the furthest.
- **Its propeller**, with part of the reduction gear, had two blades cut short and another two bent almost into a U; it also fell a long way off.

This gives reason to suppose:

- **Propeller No. 1** would have struck the port wing of the fighter aircraft, dissipating part of its rotational energy, and would have become detached from the engine after the breakage of the reduction gear.
- **At practically the same time** engine No. 1 would have become detached from the wing, following the deceleration caused by the impact of collision.
- **Since the work** entailed by the bending of the blades, the breakage of the reduction gear and the breakage of the engine attachments to the wing may be considered in toto as small in value in relation to the kinetic energy of the propeller turbine engine, it is to be presumed that engine and propeller followed close trajectories such that the point of collision would lie approximately along the alignment along the ground of the two items of wreckage.

Instrument Readings

The navigational instruments, which were photographed as soon as they were found, were the following:

- **Master indicator** of the gyrosyn showed a heading of 123 deg. true.
- **Heading selector** of the zero reader indicated 126 deg. true.
- **On the indicator** of the radio compass (ADF) of the second pilot, the green needle was "crazy" and the red needle at 31 deg.

The above indications will show the Viscount's heading at the moment of the collision if the interruption in the power supply in the aircraft circuits was instantaneous at the time of the collision.

On the first pilot's repeater, the course needle was missing but the course had been preset to 158 deg. The second pilot's repeater indicated 240 deg. T and was preset to 134 deg. The main selector switch on the zero reader control panel was set to the flight instrument position. On the same panel, the automatic pilot was selected, but it was not possible to establish whether the electric control was also selected.

The parachute with which the fighter pilot was saved was the Irving B.4 back

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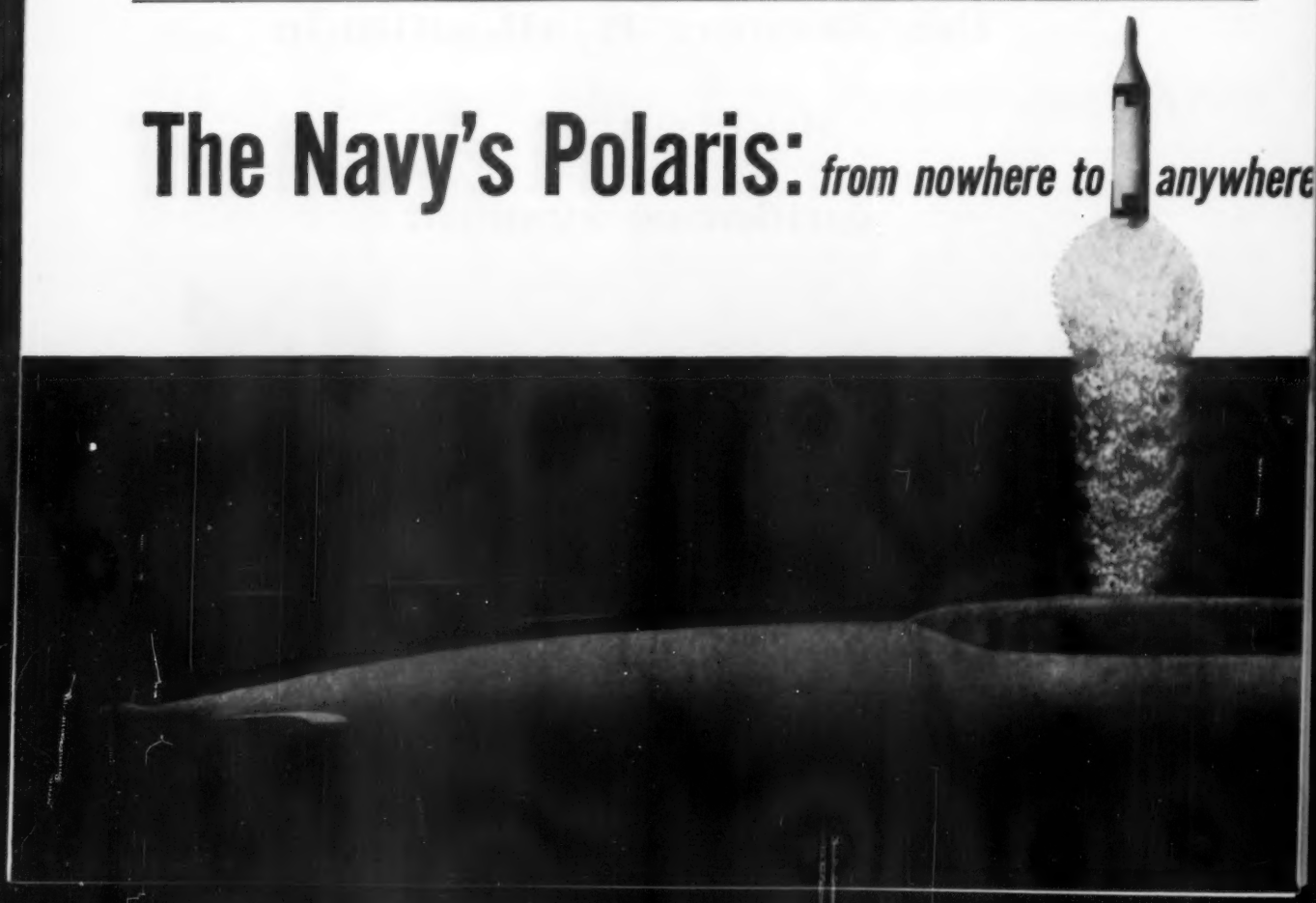

type. Many witnesses remember seeing it deployed at altitude but they give no details on the basis of which the height of opening can be determined. The parachute came down into a tall tree. The pilot received assistance a short time afterwards.

On technical examination the parachute was found to be intact; only the override "D" ring was missing. The automatic barostat was set to operate at 15,000 ft. with a delay of 2 sec.; it could not function, however, as the relevant safety pin was still in position.

The pilot remembers absolutely nothing about the descent, as he lost consciousness at the moment of the collision.

It is assumed that the parachute must have opened by chance, perhaps because of inadvertent pull of the "D" ring on the collision, or more probably because the "D" ring itself became entangled during the ejection of the pilot's seat.

Reconstruction of the trajectory of descent of the parachute has been attempted, but the data for wind in the area are uncertain, so that reconstruction cannot be accurate.

Insufficient Data

Furthermore, there are not sufficient data regarding the height of opening of the parachute. It may be noted, however, that the point of descent of the parachute was about 500 meters east of the point of fall of the pilot's seat.

The wreckage shows clearly that the collision occurred between the forward part of the Viscount on the port side and the under surface of the fighter aircraft which was in a diving attitude.

The fact that only a few parts of the starboard wing of the fighter aircraft were identified (found in different areas a long way off) leads to the hypothesis that the wing disintegrated. This disintegration might have been due to:

- **Collision with the fuselage** of the Viscount, between the forward door and the cockpit (area in which the structure has not been identified).
- **Possible effect** of explosion of the fuel in the wing tank of the fighter aircraft.

Fuel Burns

It is to be supposed that the fuel which emerged from the port wing tanks of the Viscount also caught fire and contributed to the formation of the extensive dark cloud which is recalled by the witnesses.

Further evidence of direct collision is given by the lacerations produced by engine No. 2 of the Viscount in the wing center section and the starboard wing root of the fighter aircraft in which collision the engine was reduced to fragments.

The state of the leading edge of the port wing of the fighter aircraft gives reason to suppose that it collided in area A with the wing leading edge of the Viscount, between engines No. 1 and 2.

From the statements of the pilots of the fighter formation, from the presumable attitude of the two aircraft and from their respective speeds, it may be deduced that at the moment of the collision:

- **Longitudinal plane** of symmetry of the

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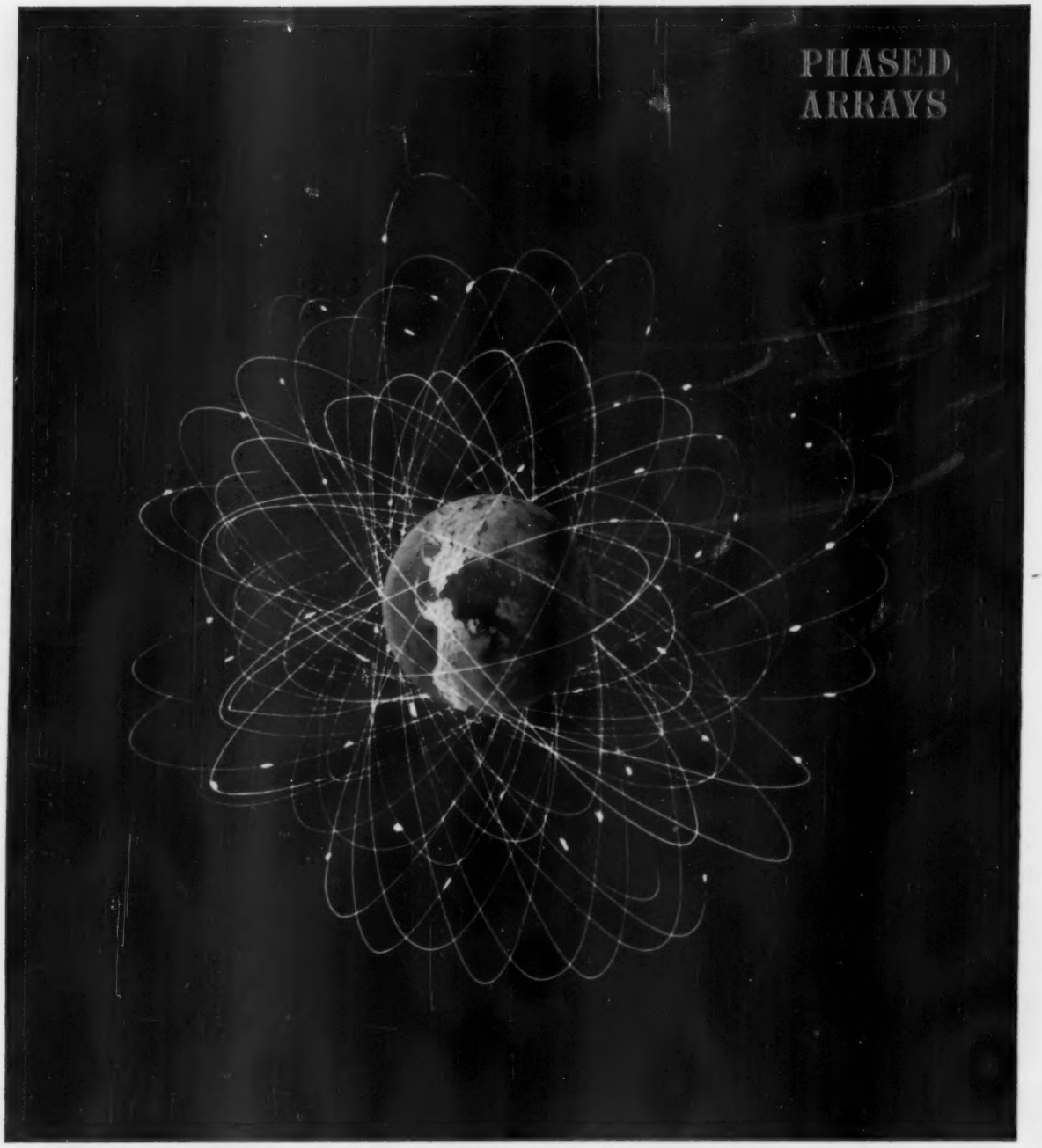

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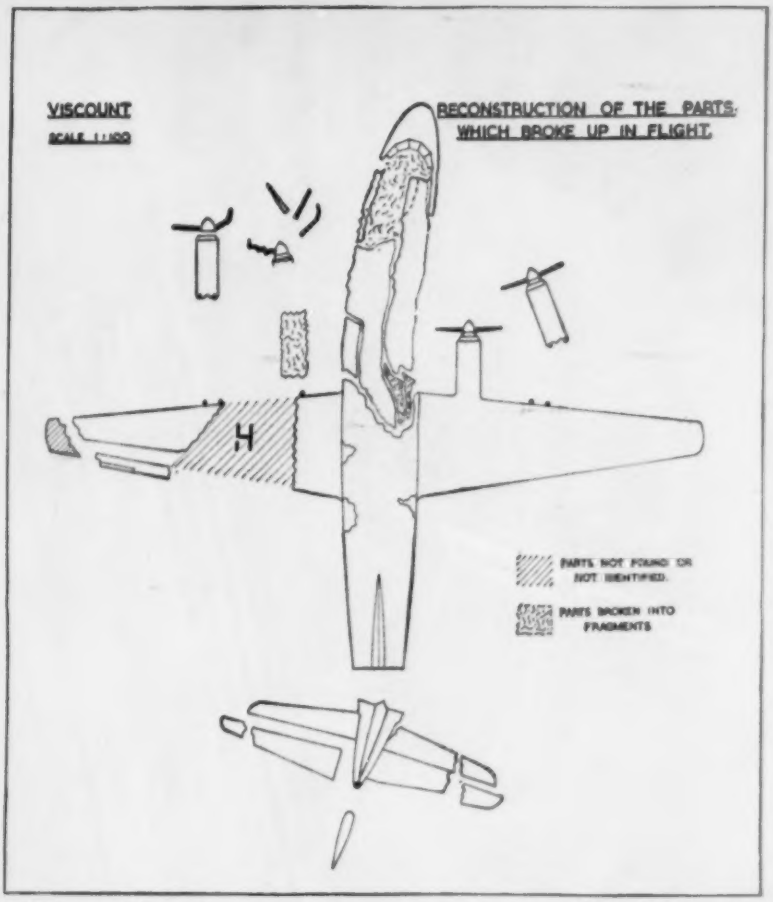

ANGULAR acceleration in yaw and roll planes, due to impact, caused tail cone separation.

fighter aircraft was approximately vertical.

- **Longitudinal axis** of the fighter aircraft was at an angle of 70 deg. in relation to the horizontal.
- **Angle in plane** of the longitudinal planes of symmetry of the two aircraft was 45 deg. to 50 deg.

The collision may be reconstructed in approximately the following way:

- **Probable collision** of the starboard wing of the fighter aircraft with the fuselage (nose) of the Viscount.
- **Port wing of the fighter** aircraft against propellers No. 1 and 2 of the Viscount, with initial fracture in area K of the fighter aricraft and detachment of propeller No. 1 of the Viscount.
- **Wing center section** of the fighter aircraft against propeller turbine engine No. 2, with fracture of the wing center section itself, probable explosion of the fuel in the wing of the fighter aircraft and consequent disintegration of the starboard wing.
- **Expulsion of the pilot's seat of the** fighter aircraft with the pilot.
- **Detachment by inertia** of engine No. 1 of the Viscount.
- **Impact of the port wing** leading edge of the fighter aircraft and the leading edge of the port wing of the Viscount, with breakage and detachment of parts 28, 31 and 38 of the port wing of the fighter.
- **Fragmentation of the rear part** of the fuselage of the fighter aircraft and of the port wing of the Viscount at area H as a result of interpenetration of the respective parts of the two aircraft and consequent wreckage.
- **Breaking up of the turbojet** engine of the fighter aircraft and detachment of the tail unit.

Angular Accelerations

As regards the Viscount, the collision must have caused angular accelerations in the yawing and rolling planes.

These accelerations contributed to the detachment of the tail cone of the fuselage carrying the tail unit, and also of propeller turbine engine No. 4.

The breakage of the starboard tailplane across the line of an elevator-hinge can also be attributed to the above accelerations.

The multiple fractures of the nose and some other breakages along the fuselage would appear to be attributable to the combined effect of collision, inertial forces and pressure waves (initial explosive decompression, immediate counter pressures, explosion of the starboard wing of the fighter aircraft).

The breaking off of the end of the fin and of the horizontal tail surfaces on the starboard side of the Viscount appears

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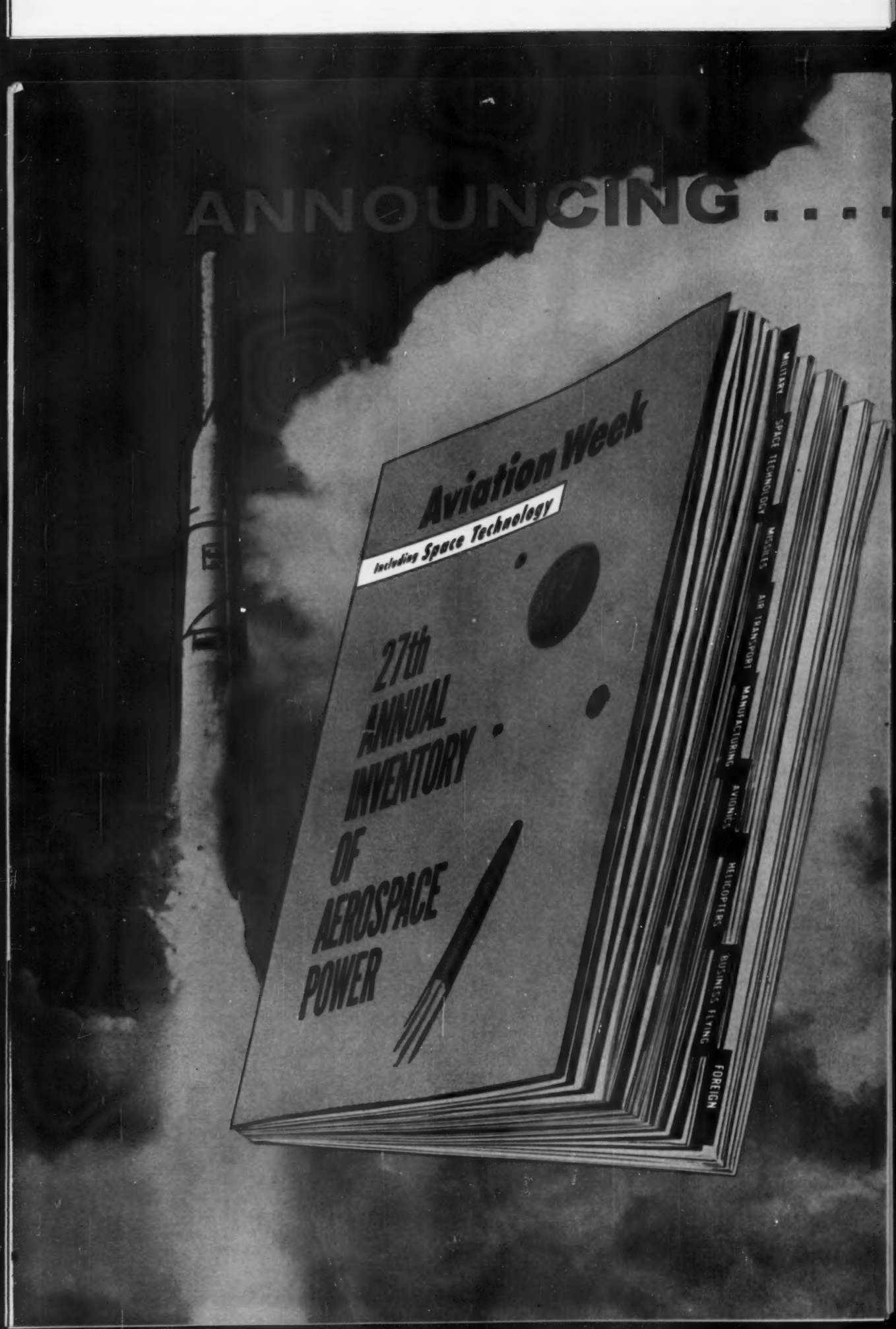
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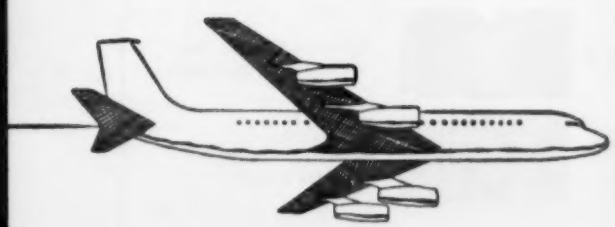

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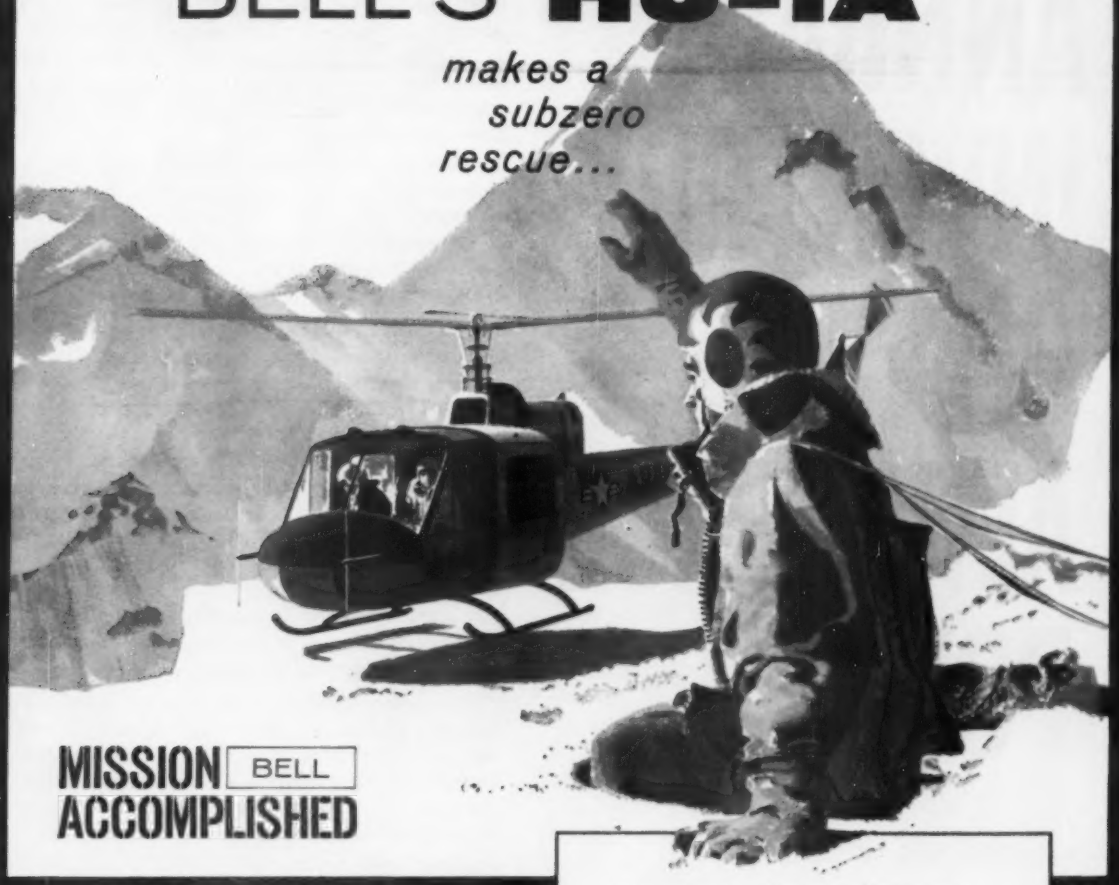

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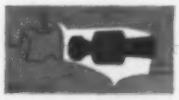

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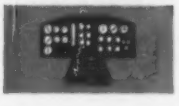

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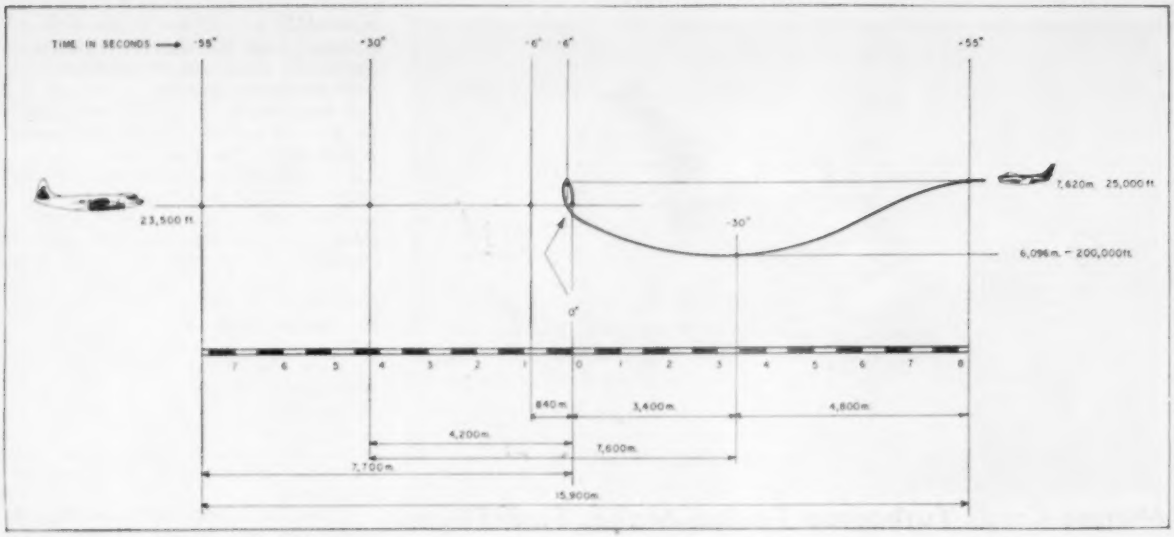


DISTANCE of about 16 km. separated the leader of the jet formation and the Viscount when the dive maneuver started.

to be due to the cutting action of metal sheets which had become detached from the nose.

The collision as described above must have occupied a very short space of time, of approximately $\frac{1}{10}$ sec.

Airway System

As regards the route through Italian air space, the flight BEA 142 used the system of airways under the jurisdiction of Milan and Rome Area Control Centers. The airways actually followed by the Viscount were Airways A3 and A1.

In compliance with current control procedures, the Viscount was in communication with Milan Control from abeam Mont Blanc to abeam Pisa NDB (south limit of Milan Flight Information Region).

It was then in communication with Rome Control until over Ostia.

The Viscount entered into communication with Milan Control at 1029 hr. At 1111 hr the aircraft was abeam Pisa NDB and was transferred to the Rome North Sector Control. In communication with Rome Control on 119.3 mc., the aircraft was given advisory service up to Civitavecchia NDB (1138 hr.), and then transferred to the Rome South Sector Control (125.5 kc.).

At 1144 hr. the Viscount reported flight over Ostia NDB and estimated flight over Ponza NDB for 1157 hr. At 1153 hr., Rome Control, following reports received about an accident near Anzio, repeatedly called the Viscount without obtaining a reply. Immediately after receiving news of the accident, Rome ACC/FIC and Pratica di Mare Base notified the Air Rescue services with the regular DISTRERFA message.

Radio Transmissions

At approximately the time of the accident (approximately 1150 hr.) the following communications were received and recorded at Rome ACC:

- **On 125.5 mc.** at 1149 hr. 30 sec., communication from the aircraft BRAVO ROMEO relating to flight over Ostia.
- **On the same frequency,** at 1150 hr., communication from military aircraft 511 relating to flight over Ostia.
- **On 124.9 kc.,** at 1151 hr. 30 sec., communication from the aircraft Alitalia 313 which reported sighting the cloud of smoke near Anzio.

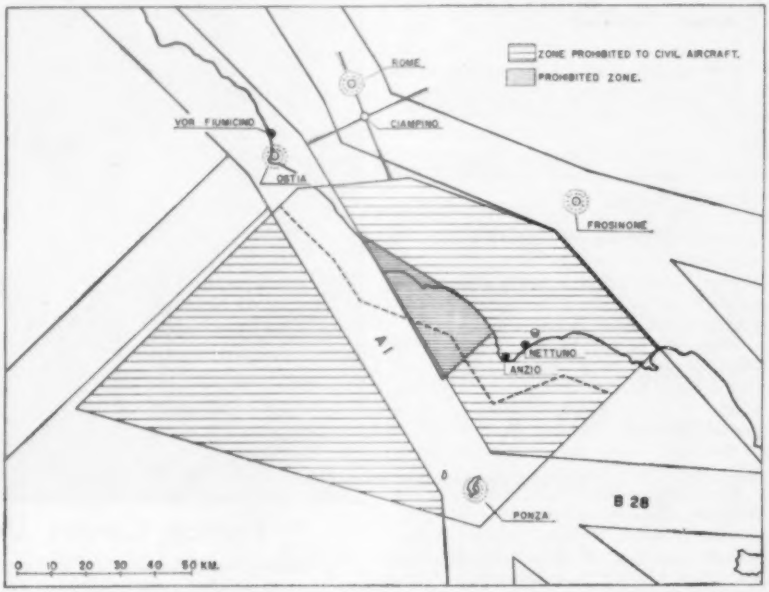
There is no doubt that there was only one collision and that it gave rise to the immediate catastrophe.

In fact:

- **Wreckage of the two** aircraft forms two sufficiently distinct and nearby groups.
- **Wreckage of the fighter** aircraft shows that it was in a steep dive at the moment of the collision.
- **Except for the turbine** of the fighter aircraft (to be considered as abnormal in this connection) no parts were found which were a long way from the two groups.
- **No wreckage showed** evidence of contacts or collisions which had occurred before the collision.
- **There was no breakup** of the fighter formation until the collision of the formation leader.
- **Pilots who were witnesses** did not see the Viscount before the collision.

Prohibited Area

There is no doubt that the collision occurred outside the airway, in an area which is well known to be prohibited. In fact, all the witnesses agree in locating the dark cloud following the collision as over the land. In the case of the Viscount, the wreckage shows that it was coming from a sector approximating to the northwest. Even on the hypothesis of a col-



MAP SHOWS relation of the crash area (near Nettuno) and the airway connecting Ponza and Ostia. The zone is prohibited to civil aircraft.

Marine Corps Turboprop Tanker Makes First Flight

Lockheed GV-1 turboprop (an advanced C-130 Hercules) aerial tanker developed for Navy and Marines makes first flight from Lockheed's Marietta, Ga., facility. Refueling drogues are extended from pods slung under wings. Fuel is carried in a 3,600-gal. internal tank.

lision occurring on the eastern edge of the airway, the wreckage could not have fallen in the place where it was located nor have been distributed in the same way, allowing for all the circumstances.

The references given in the statements of PANTALEO (at Nettuno) and PROVVIDENTE (at the Grillo battery) are sufficient to locate the collision in an area near locality of Ponsarico.

This location is the logical outcome of the distance from Ostia (48 km.), in relation to the elapsed time (about 6 min.) and to the speed of the Viscount (500 km./hr.); the alignment of engine No. 1 and propeller No. 1 and the relative distances traveled and the distribution of the wreckage of both aircraft.

Viscount Heading

It is only known that at the moment of collision the Viscount was coming from a sector approximating to the northwest; the wind force was negligible in relation to the airspeed of the Viscount (500 km./hr.), and at 1144 hr., the Viscount reported that it was over Ostia NDB and intended to head for Ponza.

At 1150 hr. the collision had already occurred, in a locality approximately 48 km. away from Ostia NDB.

The time of 6 min. is barely sufficient to cover the distance from the reporting point (Ostia) to the point of collision.

From this it can be deduced that the effective route must have approximated very closely to the line joining the two points: in other words, it does not seem possible that the Viscount, on that section of the flight, made any considerable deviations from the direct track.

The following three hypotheses can be formulated: deliberate deviation; deviation on account of feared collision with the fighter aircraft; deviation on account of imperfect navigation.

No. 1. Starting from a point near Ostia, the pilot might have deliberately headed for the airport of destination (Naples), thus finding himself at the point of collision after about 6 min.

In favor of this hypothesis, there is the consideration that, in view of the altitude of flight and the excellent visibility conditions, the Viscount pilot may have judged that there was no real risk in passing through the Prohibited Area, which passage would shorten the route to Naples.

It may be observed in this connection that the arrival at Naples of Flight 142 was scheduled in the timetable of the service for 1210 hr. As the Viscount had reported passage over Ostia at 1144 hr., it would not have arrived at Naples Airport before 1217 hr., in view of the time required to cover the distance Ostia-Ponza-Naples (28 min.) and the acrodrome air traffic procedures (5 min.).

It may also be noted that over Ostia the pilot did not ask to begin the descent, as indicated in the flight plan.

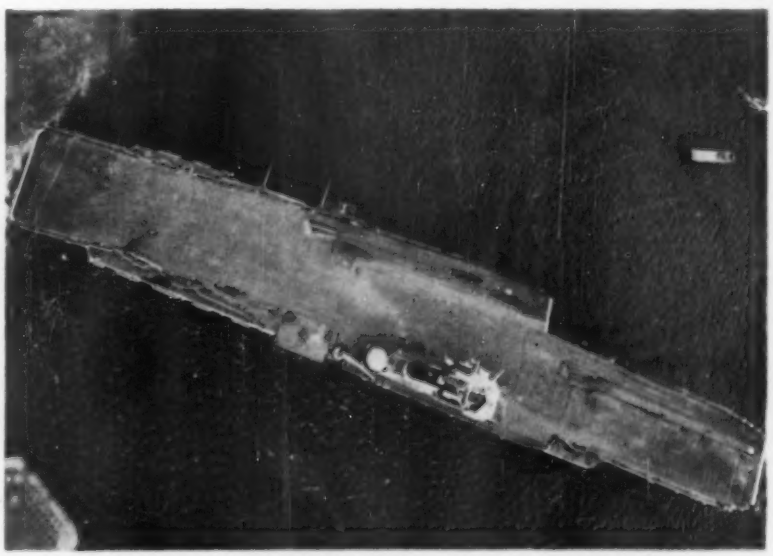
He maintained the altitude of 23,500 ft., cleared by Rome Air Control Center.

The Viscount's arrival from an approximately northwest sector, deduced from the distribution of the wreckage, would agree with the above hypothesis. More definite confirmation of this direction would also be obtained from the position of the course needles (123 deg. and 126 deg.) found on the master indicator and zero reader and from the relative bearing of 31 deg. indicated by the radio compass, if it were assumed, as is probable, that the power supply to the aircraft circuits was interrupted instantaneously at the moment of collision.

Against this hypothesis, it must be considered that such deliberate action, if not to be excluded entirely, seems very unlikely, since the service career of the commander of the Viscount shows him to be a man of unquestionable professional reliability and conscientiousness and therefore he would hardly have committed a navigational irregularity which, moreover, would only have procured him a negligible saving in time over the whole flight.

No. 2. The pilot, finding that he was flying near the east edge of the airway, might have been led to leave the airway in order to avoid the fighter aircraft which, seen from a long way off, may have appeared to him to have been carrying out maneuvers as the result of which collision trajectories in the airway could be presumed.

The acceptance of such a hypothesis



French Carrier Undergoes Sea Trials

First French aircraft carrier, the Clemenceau, shown leaving the harbor at Brest, is slated for sea duty in 1962 (AW Dec. 7, p. 137). Carrier will carry about 60 aircraft, mostly Dassault Etendard 4 strike fighters and Breguet Alize anti-submarine planes. Caned landing deck stretches about 500 ft. off main deck at 8.7 deg. angle.

leads to the assumption that the commander of the Viscount, having seen the fighter aircraft maneuvering to the east of the airway and judging that they were heading for the airway itself, would have turned to the left.

Against this hypothesis is the consideration that the Viscount pilot would not only have to have seen the fighter aircraft at an impossible distance but even to have estimated their track with such accuracy that he was able to assess the probability of a collision and leave the airway accordingly.

Furthermore, as the hypothesis is based on the presupposition that the Viscount pilot had seen the fighter aircraft from a long way off, he would logically have maneuvered, after leaving the airway, so as to keep these aircraft always within sight. Under these conditions it is difficult to explain a collision on the nose.

Hypothesis No. 3

The pilot, who initially intended to fly along the Ostia-Ponza airway, might have gradually and inadvertently left it on account of imperfect navigation.

In favor of this hypothesis, it must be noted that navigation was being carried out under the following conditions:

- **On the day** of the accident the course of the wind in the vicinity of Rome was somewhat irregular over the coast of the Upper Tyrrhenian; in particular, strong northeast winds were blowing, but at Rome they had changed to practically the opposite direction and also varied greatly in force.
- **Crew's knowledge** of the weather situation was obtained from the forecasts received on departure from London, but they had in any event to adjust the correction for drift in accordance with direct observation of the local situation.
- **Aircraft** did not carry VOR equipment.
- **Radio compass** (ADF) tuned on to medium frequency radio beacons sometimes gives somewhat unreliable indications.

Under this hypothesis, as the result of rapidly varying drift, the Viscount might have flown on the landward side of Ostia NDB when at 1144 hr. it reported as "over" the NDB.

From here it would have continued on a route close to the eastern edge of the airway, going continually farther away from the center line of the airway itself.

Against this hypothesis is the fact that the navigation from London to Ostia was carried out regularly, and also the consideration that the excellent visibility conditions between Ostia and Ponza made it possible to reach Ponza via the direct route without any difficulty.

It should also be noted that in the section between Ostia and Ponza, the airway is contained within two Prohibited Areas which would obviously have given cause for the Viscount pilot to exercise particular care in the conduct of the navigation.

CONCLUSION

The Commission gave the following views on the probability of each of the above hypotheses:

PROBLEMATICAL RECREATIONS 1

Three men, A, B, and C, with their wives, A_1, B_1, and C_1 buy some objects. Afterwards each finds that the average cost in rupees of the article he or she has purchased is equal to the number of his or her purchases. A has purchased 23 more articles than B_1 and B has purchased 11 more than A_1. Each husband has spent 63 rupees more than his wife. Who is the husband of whom?

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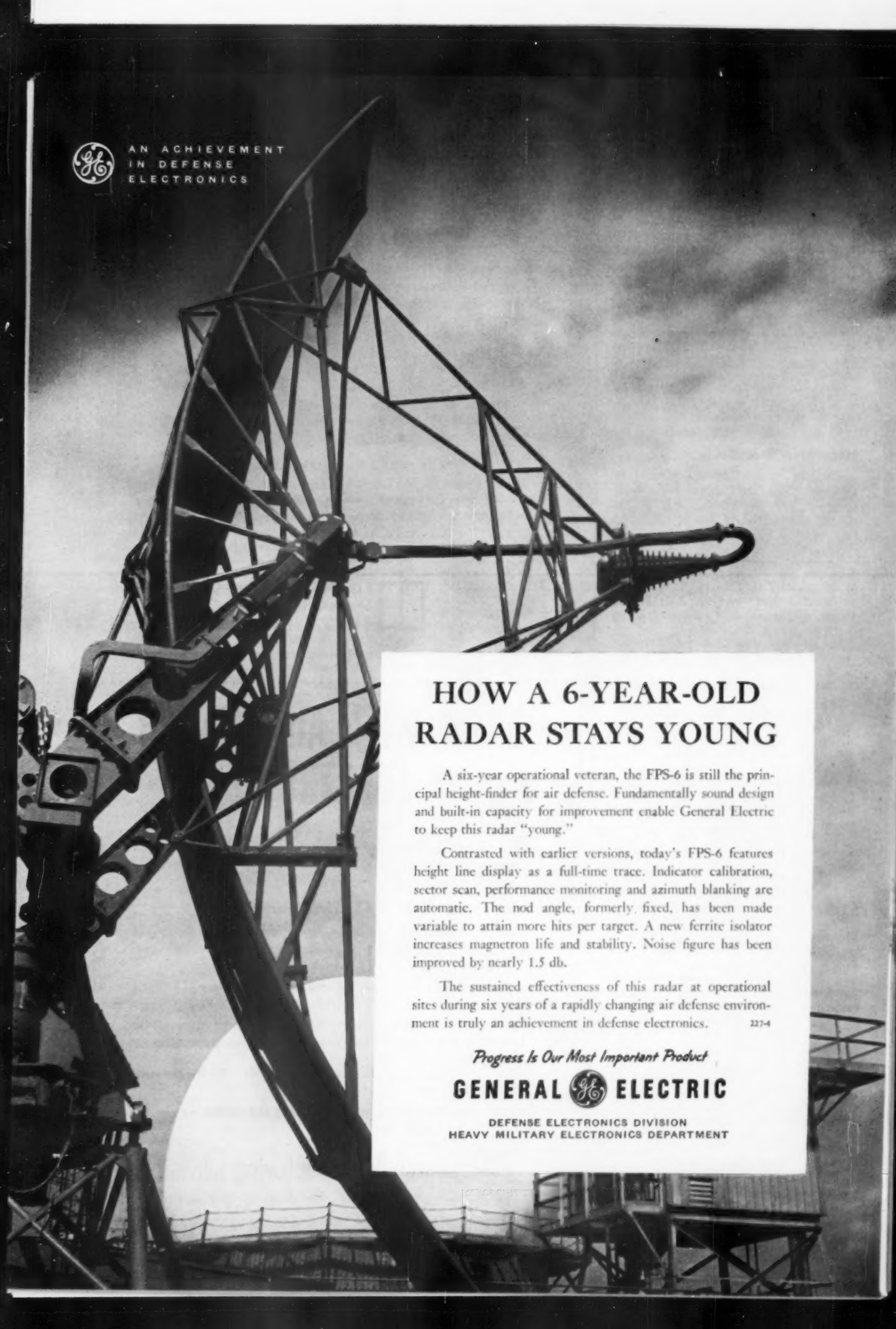

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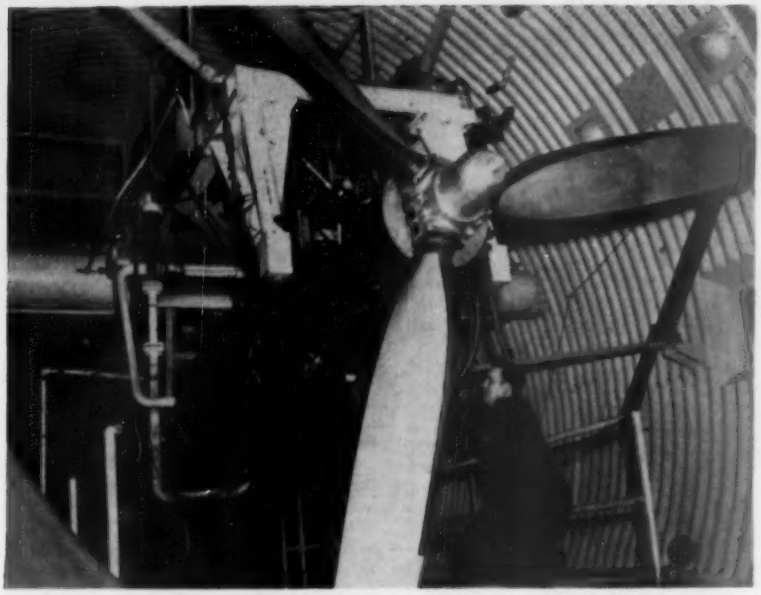

General Electric Develops Fourth T64 Version

Fourth turboprop version of the General Electric T64 has been designated the T64-GE-8 and mounts the propeller reduction gear above the engine's centerline. Other versions are a direct drive, a turboshaft and another turboprop (AW June 8, p. 61), developed under a $58 million U. S. Navy contract. New version produces 2,650 eshp. at a specific fuel consumption of 0.506. Weight is 713 lb. Company is operating four T64 test cells.

- **Four members** consider hypothesis No. 1 (deliberate deviation) to be the most probable.
- **No member** considers hypothesis No. 2 (deviation on account of feared collision with the fighter aircraft) to be the most probable.
- **Seven members** consider hypothesis No. 3 (deviation owing to imperfect navigation) to be the most probable.

As previously stated, on Oct. 22, 1958, the Viscount G-ANHC was operating scheduled service 142 which should have adhered to the following timetable: London—departure, 0825; Naples—arrival, 1210; Naples—departure, 1255; Malta—arrival, 1430.

As shown in the flight plan, the flight should have followed the Airways A3, A1 and B28. The takeoff from London was made at 0841 hr.

The section of the route between London and Geneva was flown in accordance with the flight plan. This is shown from examination of the Decca recording recovered from the wreckage of the aircraft.

The section of the route between Geneva and Ostia was also presumably covered in accordance with the flight plan, according to the times of overflight of the various reporting points. The cruising altitude was 21,500 ft. until entry into Milan FIR and was increased to 23,500 ft. before reaching Turin on clearance from Milan ACC. This altitude was maintained until the time of the accident, on clearance from Rome ACC. The speed planned (262 kt.) was effectively maintained. The last communication made by the Viscount to Rome ACC was that relating to flight over Ostia, at 1144 hr.

The collision between the Viscount and the fighter aircraft occurred shortly before 1150 hr., for that time appears in the first report of the accident made by the controller on duty at Pratica di Mare tower who saw the cloud of smoke of the explosion.

In view of the Viscount's message from Ostia at 1144 hr. and of the groundspeed maintained up to that time, i.e. approximately 262 kt., it is to be presumed that the section Ostia-Ponza-Naples would have been covered in 27 or 28 min. It is observed however that, whereas in the flight plan descent was to begin at Ostia, even after Ostia the Viscount maintained the cruising altitude of 23,500 ft. cleared by Rome ACC.

The formation of four F-86E aircraft, to which the jet aircraft which collided with the Viscount belonged, had taken off from Pratica di Mare airfield at 1045 hr. in order to carry out training in tactical formation in the eastern part of Prohibited Area No. 15 specifically assigned to the 4th Air Brigade ("Aerobrigata") for training and prohibited to civil aircraft.

After about one hour's training, on the basis of the statements of the pilots of the fighter formation, the last stage of the flight before the collision can be reconstructed as follows:

In the area approximately 5 km. east of Anzio, flying on a heading of about 310 deg., the fighter formation carried out a maneuver for changing direction by 180 deg., consisting of an initial dive and a right hand climbing turn ending in a dive from which horizontal flight is resumed in the opposite direction.

The formation was in line astern, with the members about 50 meters apart.

The maneuver had begun on a heading of approximately 310 deg. and would be completed on the reciprocal heading, i.e. about 130 deg.

The initial altitude was 25,000 ft.; at

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the end of the initial dive it was 20,000 ft. and at the top of the climb it was again about 25,000 ft.

During the diving phase following the climbing turn, the leader of the formation collided with the Viscount aircraft.

From the drawing (p. 151), given a Viscount speed of approximately 500 km./hr., it can be deduced that there was a distance of approximately 16 km. between the leader of the formation of F-86E aircraft and the Viscount, at the moment in which the F-86E formation began its maneuver (55 sec. before the collision).

In reality none of the pilots of the formation saw the Viscount before the collision.

CAUSES

The disaster is to be attributed to a fortuitious and fatal conjunction of circumstances ("fatalità (act of God)")[1] as the "immediate"[2] cause in that the collision occurred without the pilots' seeing the aircraft with which their own aircraft was moving into collision. This is certain in the case of the fighter aircraft; it is presumable and probable in the case of the Viscount.

The "earlier" cause[2] which led to the occurrence of the accident is the deviation from the airway of the Viscount which found itself in a Prohibited Area reserved for military activity.

[1] The words "act of God" are inserted in brackets in the Italian text after the word "fatalità" which has been rendered in this translation as "a fortuitous and fatal conjunction of circumstances."

[2] In the Italian text the words "immediata" (immediate) and "precedenta" (earlier) are in inverted commas—(Translator).

RECOMMENDATIONS

The recommendations which in the opinion of the Commission should be made in respect of the air collision in question, in order to avoid as far as possible the recurrence of such serious accidents, are as follows:

1. That areas which are declared to be prohibited because they are reserved for military activities be removed from the vicinity of Terminal Control Areas and airways. In the case of any military airfields located inside Terminal Control Areas, the corresponding reserved areas should be limited solely to the control zones prescribed for the exit and entry procedures.
2. That the radio navigation facilities be modernized, in order that aircraft may have simpler and more accurate methods for the conduct of navigation. With regard to Italy, that the completion of the VOR plan be speeded up.
3. That the airlines be invited to equip aircraft with aids appropriate for the use of the best facilities available along the routes.
4. That radar facilities be provided for the control services in order to provide a more efficient service and more effective control both in terminal areas and along airways.
5. That the attention of pilots be recalled to the necessity for absolute compliance with the rules governing air traffic. (It should be noted that during the year 1958 alone Prohibited Area No. 15 was flown over 36 times, including 14 times after the accident in question.)

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Capt. Frank Foster was born Feb. 23, 1919, and was 39 years old; he was married and had one child. He joined the Royal Air Force in 1939 in which he flew mainly in training and transport aircraft, and in 1946 he left the service after completing 2,326 hr. of flight time, including 1,990 hr. as first pilot.

In June, 1946, he was engaged by British European Airways as first officer and was promoted to captain in 1946; at the time he was flying in Dakota aircraft. He subsequently flew as aircraft commander in Viking and Elizabethan aircraft. He completed the Viscount 701 course in January, 1958, and his last flight check was completed on July 16, 1958.

Capt. Foster had logged a total of 8,314 hr. flight time with British European Airways, including 8,188 hr. as aircraft commander. He held ICAO Airline Transport Pilot's License No. 16178, issued on July 23, 1958, and valid until Jan. 1, 1959, by virtue of which he was entitled to fly in

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the Viscount as pilot-in-charge, on public transport services. He had his last medical examination on July 11, 1958. Total flight time in the last 24 hr: 3 hr. 9 min.

The copilot, Second Officer G. B. Wright, was born on Sept. 10, 1923, and was 35 years of age. He was engaged by British European Airways in October, 1957. He held Commercial Pilot's License No. 51806, issued on Aug. 5, 1958, and valid until Feb. 4, 1959, which was endorsed in Group I for Viscount aircraft.

He took his last flight check on July 4, 1958. Total flight time, 1,355 hr.; total flight time with BEA, 334 hr.; total flight time in the Viscount, 332 hr.; total flight time in the last 90 days, 190 hr.; total flight time in last 24 hr., 3 hr. 30 min.

Flight Radio Operator J. Bannon was born on Apr. 5, 1915, and was 43 years of age. He was married with two children. He served in the Royal Air Force from 1935 to 1946 as a radio operator. He was engaged by British European Airways in June, 1947, and since that date he had completed a total of 6,719 hr. flight time. Mr. Bannon held First Class Flight Radio Telegraphy Operator's License No. 2067, issued on May 5, 1958, and valid until May 1, 1959. His last medical examination was on Apr. 2, 1958.

Capitano Pilota Giovanni Savorelli, pilot, commanding officer of a flight ("squadriglia"); 28 years of age, military pilot's certificate, rating for F-86E aircraft. Total flight time, 1,151 hr. 55 min.; on type F-86E, 581 hr. 35 min.; in the last 90 days, 85 hr. 35 min.

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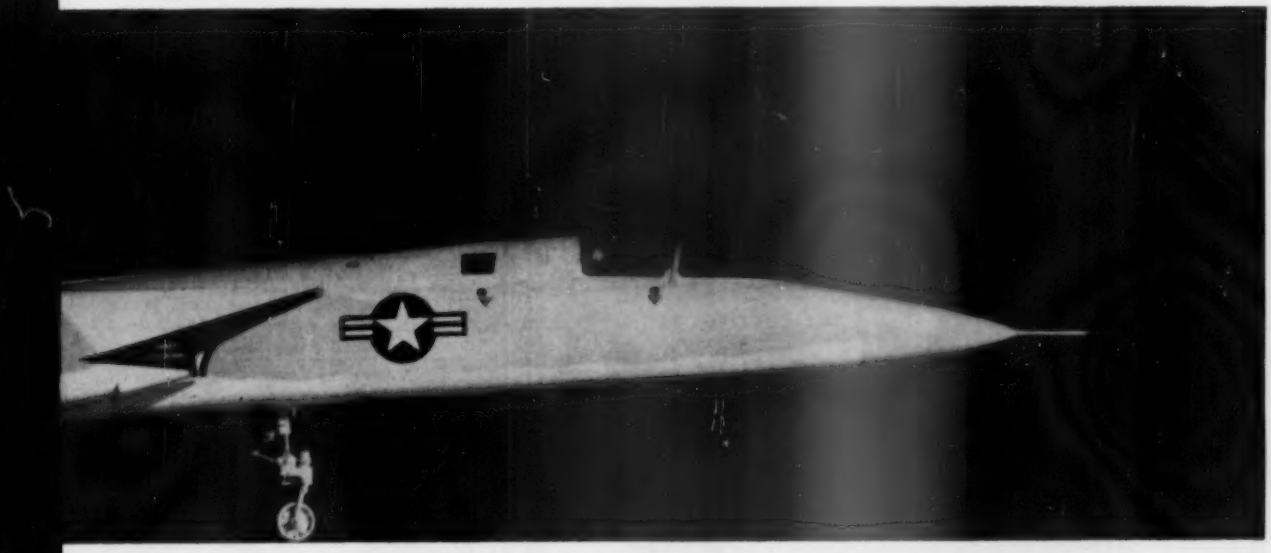

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(Continued from page 23)

Changes

Andrew J. Kutler, program manager-simulation devices, Astrionics Division, Fairchild Engine & Airplane Corp., Wyandanch, N. Y.

William S. Schueler, head of the design engineering group, Research and Engineering Division, Data-Control Systems, Inc., Danbury, Conn.

John C. Keyes, manager-satellite systems engineering department, Philco Corp.'s Western Development Laboratories, Palo Alto, Calif.

Robert J. Gilson, director of systems management, Electronics Division, Stromber-Carlson, Rochester, N. Y., a division of General Dynamics Corp.

Capt. Robert S. Camera (USN, ret.), executive engineer, Piasecki Aircraft Corp., Philadelphia, Pa.

George Anisman, research and product planning manager, Whittaker Controls Division, Telecomputing Corp., Los Angeles, Calif.

Raymond B. Slaney, manager, Operations Planning Department, Space Technology Laboratories, Inc., El Segundo, Calif.

Fred F. Richards, Sr., section manager of production, Temco Electronics, a division of Temco Aircraft Corp., Dallas, Tex.

Leroy Simpson has joined R. Dixon Speas Associates, Manhasset, N. Y.

W. Lawrence Brantley, manager, Washington (D.C.) office, Giannini Controls Corp., Pasadena, Calif.

Dr. Alan E. Johnsrud has joined National Engineering Science Co., Pasadena, Calif. Also: **Dr. Robert E. Williams** has joined NESCO's Technical Staff, and **Drs. Lewis B. McCammon, Lars Skjelbreia** and **Gunnar B. Bergman** have been appointed to NESCO's Senior Staff.

Earl J. Shelton, director of development, Eitel-McCullough, Inc., San Carlos, Calif.

Charles M. Edwards, assistant to the executive vice president of Bendix Aviation Corp., Detroit, Mich., and **Dr. G. A. Rouclot**, assistant general manager and associate director of the company's Research Laboratories Division. Also: **E. O. Cooper**, national director of aircraft service for Bendix.

Dr. Lloyd P. Smith, general operations manager of the newly established Research Operations of Aeronutronic, a division of Ford Motor Co., Newport Beach, Calif. Other key appointments within Research Operations: **Dr. Arthur J. Ruhlig**, manager of Physics and Computing; **Cravens L. Wanlass**, manager of Solid State Devices; **Dr. Leon Green**, acting manager of Aerothermochemistry and Materials; **Dr. Lawrence Kavanau**, manager of Planning. Also: **Dr. Montgomery H. Johnson** has been named senior staff scientist for Aeronutronic. **Dr. Donal Duncan** succeeds Dr. Johnson as general operations manager of Aeronutronic's Space Technology Operations; **Charles G. Gant**, assistant general operations manager to Dr. Duncan.

R. B. Ormsby, manager of the newly established Aerospace Technology Department, Georgia Division of Lockheed Aircraft Corp., Marietta, Ga.

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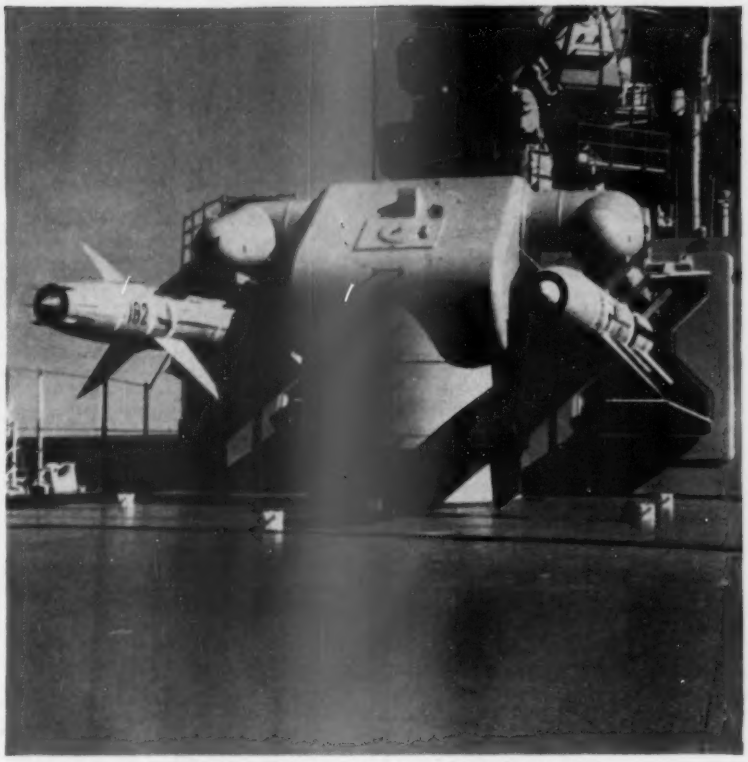

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LETTERS

Bomb Monitor

I have a proposed solution for the "hidden bomb" problem. Why not require that all manufactured explosives be "tagged" with radioactive isotopes? If a suitable isotope can be found, detection of explosives and firearms would be comparatively simple. A moving belt of luggage, and each passenger gate, could be economically and continuously monitored for telltale radiation indicating explosives or firearms. It probably would not require continuous monitoring since periodic checks would discourage the practice of concealment.

Some of the many problems and questions are as follows:

1. Is there a radioactive isotope possessing an adequate combination of: radiation that is difficult to shield; a long half life; and is harmless biologically? The amount needed should be very small on a chemical scale.

2. If such an isotope exists can it be made available at modest cost or perhaps be government furnished to explosive manufacturers?

3. What about imported explosives? Could they be prohibited without the "tag" or could the effort be made internationally? It would take some cleverness or chicanery on the part of the bomber to make absolutely sure that any acquired bootleg explosive was not tagged.

4. What about homemade explosives? At least our possible bomber group would be narrowed down to those with sufficient chemical ability to produce a good explosive, a somewhat difficult task.

The scheme would also be of great benefit to police and postal services. Even periodic tagging of certain batches of explosives might have a large effect. Unless there is an overriding objection that has not occurred to me, I propose that such a scheme be seriously studied by an organization such as the National Bureau of Standards.

Even if the proposal is marginally practicable, widespread publicity of its existence would be beneficial.

GORDON K. DICKER
Major, USAF
Rockville, Md.

Space Progress

In reply to the letter from Mr. Claflin in the Nov. 2 issue of AVIATION WEEK (p. 134) I have noticed that many replies have come to be published about his letter. None of them agree with him. I am one of his school of thought who say that there really is no race in space. When we compare American and Soviet progress we seem to judge only by the biggest feats who is ahead in this so-called race. This is, as Mr. Claflin said, mainly the fault of the reporters whose job is only to sell papers and cause confusion.

We seem to judge who is ahead in their progress by the sequence of things. If we launched the Atlas on Oct. 29 would we be ahead of the Russians in the race to the moon? Of course not. If we launched a man in orbit today and the Russians tomorrow does this mean that we were ahead of them? No. There is no way to tell who is ahead now. The year 1960 will really separate the men from the boys. We never call to mind the small accomplishments we achieve.

Do the Russians have missiles like the complex Falcon or Hound Dog? No. All they have, according to reports, are missiles like the Tiny Tim or old World War II type air-to-air missiles.

Have the Russians over 30 different models of missiles? No. Our paddlewheel had almost three times as many instruments as the supposed ton and a half Sputnik III. That brings up another point. There is no proof that their Sputniks weigh as much as the Russians say, other than a few models at exhibitions and their glow. Glow is no evidence. A 10 lb. corner reflector could look like a couple of tons up there.

The Russians have been known to beef up and lie.

If we consider everything—the variety and types of missiles, miniaturization, complexity, reliability, tracking devices, etc.—we are at least equal to them.

RICHARD NOWICKI
Buffalo, N. Y.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Duplication of Effort

This letter is biased by the fact that unemployment in this city will rise from its present 13,000 to 30,000 by next September, including 7,000 former Convair employes; also, by the fact that my salary has been fighting a losing struggle with the high cost of living, which is due basically to poor management, spendthrift philosophies, and downright stupidity among the bureaucrats in our government.

The ICBM is basically a very complicated and very accurate long range gun. If the Army were to split its infantry into two halves, each with its own special rifle which could not be used by the other half, the complicated logistics and senselessness would be apparent to all. Yet, we now have Atlas/Titan.

It has been proven by Jupiter/Thor, Bomarc/Nike, Regulus/Matador, etc., that the Department of Defense was too weak to make necessary decisions. In 1954 they set up the technically and financially astute Ramo-Wooldridge (AW Dec. 1, 1958, p. 77) to help the Air Force to make decisions. Now we have Atlas/Titan.

The Titan was sold to Congress and the American public as a "back-up" in case of failure of the Atlas. . . . In a nationwide TV program, "Space Lag," this January, Gen. Schriever was asked, "Why do we keep the Titan when the Atlas appears successful?" His alibi was that the Titan should have a better growth potential and that the Air Force had already spent loads of our money in starting work on Titan bases. Now, in AVIATION WEEK, Jan. 25 (p. 28), Secretary Gates says Titan "has a greater growth potential in terms of warhead capability and range. . . . It will just be a better missile in all respects . . . Titan will significantly increase the number of megatons you can deliver."

But, on Jan. 25, Gates told the House Space Committee that "I think it (Atlas) will reach 8,500 mi. . . . There is no need for that much range, but I think it will probably do it anyway," thus disposing of the supposed greater range advantage for Titan. As to the supposed advantage of larger explosive force, the Atlas was given the go-ahead in 1954, based on the AEC warheads at that time. By 1960, if the AEC doesn't have considerably larger yields with less weight and space, they should be investigated, too. Certainly any additional warhead yields will only result in useless "overkills."

I certainly hope that Congress will get the right people on the stand and probe their way through the fog of propaganda and brainwashing thrown up by the Eleutherian group and ask for concise answers to these questions:

1. What can the Titan do which cannot be done sooner and quicker by Atlas? (The San Diego papers have carried repeated stories during 1959 that Convair could easily double Atlas production if funded.)

2. Why do we have two Air Force ICBMs when these are only interim measures until "Minuteman" and "Polaris" (the best concept) become operational?

3. What will be the total costs, including ground and flight tests, repair to bases damaged by explosions, all site costs, all ground equipment, spares, maintenance supplies and equipment, Air Force training and expenses, etc., for the next five years, of each missile system? (Remember that the ground equipment for Thor cost 87% of the total cost. And don't let the same people figure costs who said the $110,000,000 Vanguard program would only cost $10,500,000.)

4. Do you blame us for taking money away from the B-70, in the light of the way this program is managed?

Who gains by this duplication of effort? Ask yourself if the persons who are supposed to make decisions are really unbiased? Or do they gain personal glory by expanding their empires or monetary gain by expanding operations? Of course, Nikita will remember that "we will beat the capitalists by making them spend themselves into bankruptcy."

(Name withheld by request.)

A BITTER ENGINEER
San Diego, Calif.

P.S. I note that Rocketdyne, the company that produced good rocket engines when they were needed, is laying off 900 engineers. This is the penalty for success in military contracts.

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The recent demonstration of multi-purpose test equipment (MPTE), developed by RCA under a series of Army Ordnance contracts, highlights *a new dimension in automated multi-use systems support* and culminates a long-term RCA effort in this field. This General Evaluation Equipment is an automated, transistorized, dynamic checkout system. It contains a completely modularized array of electronic and mechanical evaluation equipment, capable of checking a variety of electromechanical devices, ranging from radar subassemblies to missile guidance computers. MPTE provides the stimuli, programming, control, measurement and test functions for the NIKE AJAX, NIKE HERCULES, LACROSSE, HAWK and CORPORAL missile systems and has been extended to other weapons systems related to our defense efforts.

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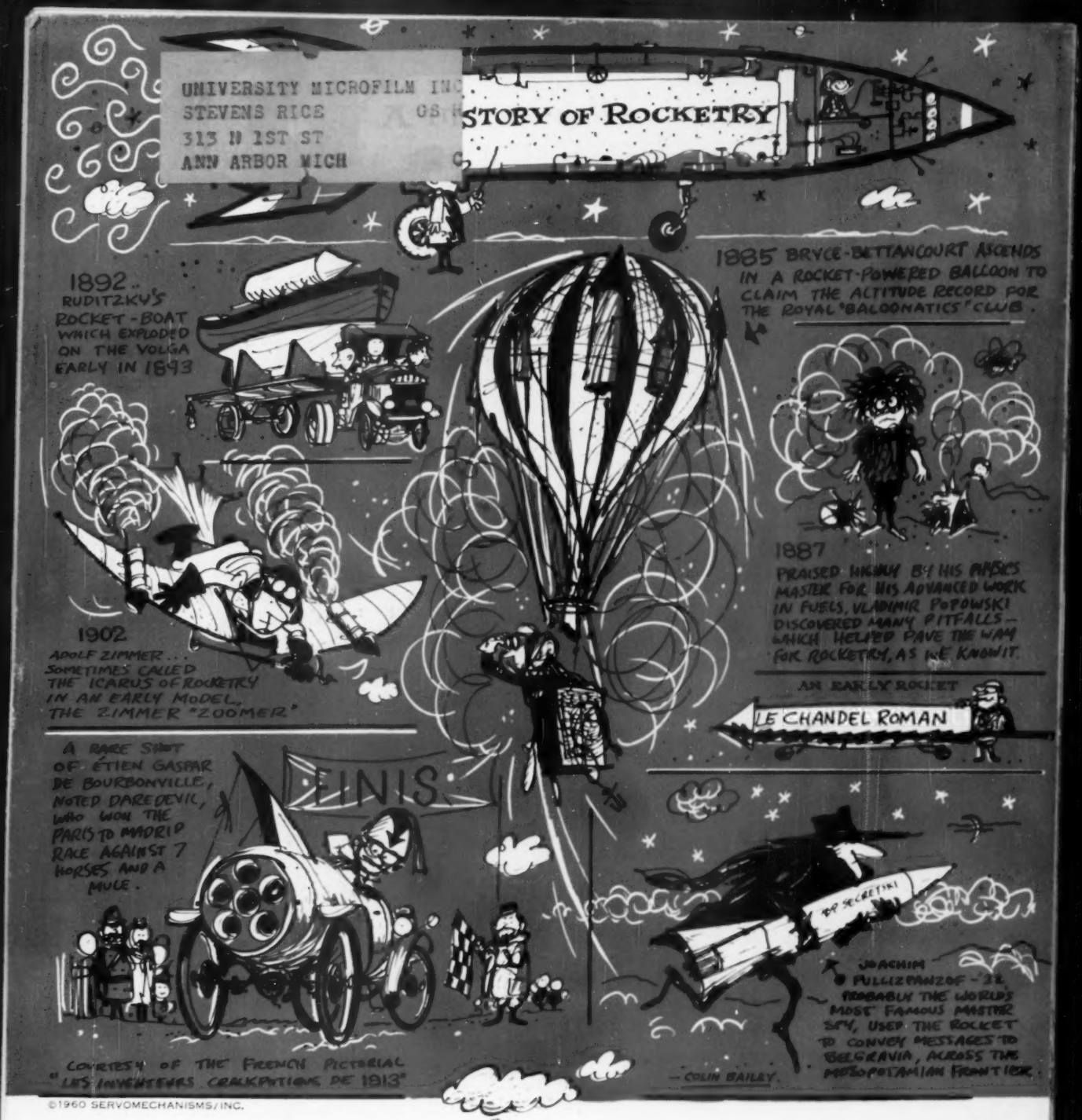
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